



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**ANALYSIS OF CIVILIAN LABOR COSTS WITHIN THE
DEPARTMENT OF THE NAVY**

by

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June 2017

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REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE June 2017		3. REPORT TYPE AND DATES COVERED Master's thesis
4. TITLE AND SUBTITLE ANALYSIS OF CIVILIAN LABOR COSTS WITHIN THE DEPARTMENT OF THE NAVY			5. FUNDING NUMBERS	
6. AUTHOR(S) Paul A. Llano				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB number ____N/A____.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (maximum 200 words) <p>Civilian labor costs rose 2.2 percent in the 12-month period ending in December 2016, according to a January 2017 Bureau of Labor Statistics cost index. Changes in labor costs can affect the financial stability of not only private corporations but also government organizations, such as the Department of the Navy (DoN). Both private and public employers must compete in the same market for skilled professionals.</p> <p>Understanding how civilian labor costs change is of particular importance to the DoN, considering that the service is a manpower-intensive organization limited by congressionally enacted restraints that affect the service's budgets. By conducting a statistical analysis of recent historical data, creating basic models, and projecting those models for the near future, this report provides a macro-level overview of the Navy's civilian labor costs so that Navy leadership can make better-informed decisions on the expenditure of limited funds.</p>				
14. SUBJECT TERMS Department of the Navy, civilian labor, full time equivalents, expenditures, benefits, compensation, linear regression, multiple regression			15. NUMBER OF PAGES 107	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UU	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18

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**ANALYSIS OF CIVILIAN LABOR COSTS WITHIN THE DEPARTMENT OF
THE NAVY**

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

**NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

Civilian labor costs rose 2.2 percent in the 12-month period ending in December 2016, according to a January 2017 Bureau of Labor Statistics cost index. Changes in labor costs can affect the financial stability of not only private corporations but also government organizations, such as the Department of the Navy (DoN). Both private and public employers must compete in the same market for skilled professionals.

Understanding how civilian labor costs change is of particular importance to the DoN, considering that the service is a manpower-intensive organization limited by congressionally enacted restraints that affect the service's budgets. By conducting a statistical analysis of recent historical data, creating basic models, and projecting those models for the near future, this report provides a macro-level overview of the Navy's civilian labor costs so that Navy leadership can make better-informed decisions on the expenditure of limited funds.

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LIST OF ACRONYMS AND ABBREVIATIONS

AcqDemo	Acquisition Demonstration
APPN	Appropriation
BLS	Bureau of Labor Statistics
BRAC	Base Realignment and Closure
BSO	Budget Submitting Office
CIVPERS	Civilian Personnel
CR	Continuing Resolution
CY	Constant Year
DOD	Department of Defense
DoN	Department of the Navy
DP	Demonstration Project
ES	End Strength
FMB	Office of Financial Management and Budget
FTE	Full Time Equivalents
FY	Fiscal Year
GDP	Gross Domestic Product
GS	General Schedule
JIC	Joint Inflation Calculator
MSC	Military Sealift Command
NAVSEA	Naval Sea Systems Command
NCCA	Naval Center for Cost Analysis
NSPS	National Security Personnel System
NWCF	Navy Working Capital Fund
OCHR	Office of Civilian Human Resources
OMN	Operations and Maintenance (Navy)
OMNR	Operations and Maintenance (Navy Reserve)
OMMC	Operations and Maintenance (Marine Corps)
OMMCR	Operations and Maintenance (Marine Corps Reserve)
OSD	Office of the Secretary of Defense
PACFLT	U.S. Pacific Fleet

PB	President's Budget
R^2	Coefficient of Determination
RD TEN	Research, Development, & Evaluation (Navy)
SES	Senior Executive Service
TY	Then Year
USFF	U.S. Fleet Forces
USN	United States Navy
USMC	United States Marine Corps

ACKNOWLEDGMENTS

There are too many people to thank for the assistance they provided and not enough space to name them all. I would like to thank Mr. Christopher Greaver, from FMB-423, who provided me with the thesis topic and helped me access the data that I used. I also want to thank my thesis advisor, Dr. Robert Eger, who in class taught me many things, but the thing that I remember most is that “people are expensive.” Without his help and guidance, I would have been lost trying to complete this project. I am also grateful to my co-advisor, Dr. Eddine Dahel, from whom I learned that even though statistics are numbers that can be warped to support any message, calculating these numbers is not that scary.

I would remiss if I did not acknowledge my family, friends, and classmates, who provided me the much-needed moral support and grounding. Last, but certainly not least, I thank my lovely wife, Nancy. During my career, she has endured prolonged separations for deployments or other duties, and at NPS, she had to deal with my extended absences so I could be with my mistress, “this thesis.”

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I. INTRODUCTION

A. PURPOSE

According to data from the United States Bureau of Labor Statistics (BLS), the cost of labor across all U.S. sectors increased 2.3 percent on average from 2006 to 2016,¹ outpacing increases in inflation and gross domestic product (GDP) (Bureau of Labor Statistics, 2017). Increases in the cost of labor are not unique to the private sector, as public entities such as the Department of the Navy (DoN) must draw talented professionals from this labor pool. Two other issues affect the DoN. First, the Navy is a manpower-intensive requiring fleet support both in port and deployed, which means labor costs comprise a large portion of its budget. Second, as with other public entities, the DoN has faced decreased funding as fiscal constraints have increased, lowering the amount of appropriations allotted.

In fiscal year (FY) 2007, the DoN employed 187,461 full-time equivalents (FTEs) (Department of the Navy, 2017). In the FY 2017 budget request, the DoN asked for appropriations to support 203,317 civilian FTEs, a 7 percent increase (Department of the Navy, 2016). With increasing global commitments requiring an increase in the number of civilian FTEs needed as well as a fiscally constrained environment that limits Department of Defense (DOD) funding, it is imperative to understand how civilian labor costs will affect future budgets to allow informed decisions to be made on expenditures.

B. RESEARCH OBJECTIVES

This thesis includes a macro-level statistical analysis of ten years of recent historical data on the DoN's civilian labor force to identify the largest cost drivers. This report evaluates the civilian labor trends in the DoN as a whole and then further analyzes the DoN civilian labor force according to the Budget Submitting Office (BSO), and Appropriations (APPN), and by the Hire Type.

¹ This information was obtained by creating a customizable search of the Employment Cost Index (NAICS) data base on the BLS website: <https://www.bls.gov/ect/>

After highlighting the largest cost drivers, the information is used to create basic models to project how these costs will change if all factors remain the same. These models serve to highlight how these costs may affect future DoN expenditures.

The purpose of highlighting these increases and creating projections is to provide Navy leaders with information on civilian labor force costs to allow them to make decisions about the allocation, programming, and budgeting of limited funds with the most information possible on the subject. This thesis does not advocate for certain programs, specific cost reduction strategies, or investment strategies, rather it serves only to highlight the general issues.

II. BACKGROUND

A. FULL TIME EQUIVALENTS

There are two ways of counting civilian personnel in the employ of the DoN: End Strength (ES) and FTE. ES counts the physical bodies performing work for the DoN, so one person working, regardless of fulltime or part-time status, counts as one ES. FTE counts the number of hours worked based on the assumption that one individual works 40 hours a week for 52 weeks. Thus, one FTE is 2,080 man-hours. Whether a worker is part-time or full-time does not affect the total number of FTEs. For example, one worker can work part time and thus count as .5 FTE since they only performed 1,040 hours of work. Another part-time worker can then work the remaining 1,040 hours. Even though two different people performed work, only one FTE is recorded. If ES had been used to determine civilian labor numbers then it would have provided an inflated number of labors while costs remained the same. This would mean that the labor would appear relatively inexpensive when compared to the total number of ES civilians.

B. HIRE TYPES

FTEs are classified in multiple ways as hire types.

1. Senior Executive Service (SES)

These individuals are the most senior civilian leaders directly beneath Presidential appointees. They act as the senior civilian leadership of the federal workforce (Office of Personnel Management, n.d.).

2. General Schedule

This hire type covers the majority of civilian employees in the DoN. General Schedule (GS) employees are paid on a scale that ranges from GS-1, the lowest paygrade, to GS-15, the highest paygrade. In addition, each of these paygrades has 10 steps, which incrementally increase the employee's salary based on numerous characteristics such as performance and tenure while they remain in the GS level appropriate for their position. (Office of Personnel Management, n.d.).

3. Wage Grade

This hire type is used to employ civilians working in positions that are normally considered blue collar, skilled trade labor and craftsman, and are paid hourly (Office of Personnel Management, n.d.).

4. Foreign National Direct

Foreign Nationals directly employed and funded by the U.S. government are considered Foreign National, Direct Hires.

5. Foreign National Indirect

Foreign Nationals directly employed by foreign governments that work for the U.S. government are considered Foreign National, Indirect Hires. These hires are funded based on the specific agreements reached by the foreign and U.S. governments.

6. National Security Personnel System

The National Security Personnel System (NSPS) is a personnel system that was created in the National Defense Authorization Act (NDAA) for FY04 to give the DOD more flexibility in compensating, rewarding, and promoting individuals (Stewart, 2005). This was accomplished through “pay bands,” which were flexible pay scales. However, the system was criticized for being too subjective and the NDAA for FY10 repealed this hire type. Beginning in 2010, the civilians classified as NSPS were re-designated as other hire types (National Security Personnel System, 2010). Information about this hire type was used in this report because it was still a valid personnel system until 2010.

7. Demonstration Project

The National Defense Authorization Act (NDAA) for FY96 created the framework for reform of the civilian labor force that specifically dealt with acquisitions. This effort began in 1999 and was designed to improve the DOD acquisition civilian labor force by creating a better personnel system than was currently in use (Department of Defense Civilian Acquisition Workforce Personnel Demonstration Project, n.d.).

Demonstration project hire types are FTEs that are part of trial programs such as the Acquisition Demonstration (AcqDemo) FTEs, which do not fit into the other hire types.

8. Civilian Mariners

These hire types are civilian mariners employed by the federal government to operate U.S.-owned ships with the Military Sealift Command (MSC) to support all of the Armed Services but primarily support of the Navy operations (Military Sealift Command, n.d.).

C. APPROPRIATIONS

Appropriations are acts of Congress that provide legal authority for the specific outlay of funds in support of specific areas of endeavor (Musell, 2009, p. 14). Funds allocated for one appropriation are to be used solely in for that appropriation unless Congress has granted authority to move funds from one appropriation to another. As a result, specific types of funding are called appropriations in budgets (Schick, 2000, p. 186).

1. Operations and Maintenance

The general title of operations and maintenance actually covers four different appropriations: Operations and Maintenance, Navy (OMN), Operations and Maintenance, Navy Reserve (OMNR), Operations and Maintenance, Marine Corps (OMMC), and Operations and Maintenance, Marine Corps Reserve (OMMCR). Costs budgeted in this appropriation are considered an expense and used to support active operations (Department of Defense, 2011, p. D1).

2. Research, Development, Test, and Evaluation, Navy (RDTEN)

Funds outlayed for this appropriation are earmarked to support research and development efforts for the U.S. Navy and Marine Corps (Department of the Navy, 2016, p. 5–1). Costs budgeted in this appropriation can be considered an expense or investment. Since this report focuses on labor these funds are considered an expense (Department of Defense, 2011, p. D1).

3. Navy Working Capital Funds

The Navy Working Capital Fund (NWCF) is a revolving fund that finances certain activities, such as shipyards and depots, which are support operational units. This fund strives to break even over a budget cycle in order to provide services for the lowest cost possible (Department of the Navy, 2016, p. 7–1).

4. Military Construction, Navy and Marine Corps

Funds outlayed as Military Construction, Navy and Marine Corps (MCN) appropriation are earmarked to support the construction of United States Navy and Marine Corps facilities (Department of the Navy, 2016, p. 6–1). Costs budgeted in this appropriation can be considered an expense or investment but, since this report focuses on labor, it will be considered an expense (Department of Defense, 2011, p. D1).

5. Base Realignment and Closure

Funds outlayed in this appropriation are earmarked to support the Base Realignment and Closure (BRAC) efforts of U.S. Navy and Marine Corps facilities. Costs budgeted in this appropriation can be considered an expense or investment, but since the report focuses on labor, these funds will be considered an expense (Department of Defense, 2011, p. D1).

6. Family Housing, Navy (Operations) (FHOPS)

This appropriation is used to operate, maintain, and oversee the U.S. Navy's family housing (Department of the Navy, 2016, p. 6–2). Costs budgeted in this appropriation can be considered an expense or investment (Department of Defense, 2011, p. D1). Like the previous APPNs, the labor costs will be considered an expense.

7. Budget Submitting Office (BSO)

A BSO is a subunit in the DoN that is responsible for submitting budget materials, reviewing work performed, and ensuring documentation is correct (Department of Defense, 2011, p. 81607).

III. LITERATURE REVIEW

As of the writing of this report, the author was able to locate seven reports written by the RAND Corporation and the Government Accountability Office (GAO) that specifically addressed the civilian workforce and related expenditures in the DoN and DOD. These reports focused on the efficiencies of military to civilian conversions of personnel, the optimal mix between civilians, contractors, and active duty personnel, as well as how to best compensate these civilians. However, these reports did not address how recent events such as sequestration, growth and reduction in the DOD budget, or other external factors affect the civilian labor force and expenditures. As a result, this literature review focuses on the research done into the different statistical methods used to develop models and create projections that can be used to estimate how much the civilian labor force will cost the DoN in the near future with the assumption that current external factors affecting the DoN budget remain in place.

A. DESCRIPTIVE STATISTICS

Descriptive statistics is the use of collected data points, which are then summarized into an easily understandable format for the end user in the form of graphs or tables. This data can then be used to identify historical trends or to create a projection for consumers of that information (Anderson, Sweeney, & Williams, 2010, p. 14). This data should be presented to convey the information in a simple and understandable format (Anderson, et al., 2010, p. 89).

1. Measures of Association between Two Variables

Variables can interact with each other in many ways. In order to conduct a thorough statistical analysis, it is important to understand the relationship different variables have with each other as well as how strong that relationship is. Covariance and Correlation Coefficient are two methods that can be used to interpret the nature and strength of a relationship between variables.

a. Covariance

Covariance (s_{xy}) is the measure of the linear association between two variables and is calculated in the following manner for samples (Anderson, et al., 2010, p. 149):

$$s_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{n - 1}$$

where

n = the sample size,

x_i and y_i = location of a data point on the x and y-axis, and

\bar{x} and \bar{y} = the average values of all x and y values.

Simply put, a positive covariance means that as one variable grows or shrinks, there is a similar reaction in the other variable. If there is a negative covariance, then the reaction of one variable is the opposite of the other (Anderson, et al., 2010, p. 151). It should be noted that a covariance of 0 does not mean that the two variables are independent of each other (i.e., statistically independent), but it could mean that the data has some type of dependency that is not easily identified (Newbold, 1995, p. 151). A limitation of covariance is that it is dependent on the units of measurement used by both variables. Thus, this reports comparison of FTEs, expenditures, and hire types would be difficult to accomplish using covariance.

b. Correlation Coefficient

Correlation Coefficient (r_{xy}) is similar to covariance in that it is another measure of the linear relationship between two variables but differs in that the difference in units does not affect the result. Values of the correlation coefficient can range from -1 to 1 with -1 indicating a perfect negative linear relationship and 1 indicating a perfect positive linear relationship. As the values approach 0, the weaker the linear relationship between the two variables is (Anderson, et al., 2010, p. 155). There may be a positive or negative relationship between two variables but that does not imply that one variable caused the

other, only that they are related in some fashion. The Correlation Coefficient for samples is calculated in the following manner (Anderson, et al., 2010, p. 151):

$$r_{xy} = \frac{s_{xy}}{s_x * s_y}$$

where

s_{xy} = the sample covariance,

s_x = sample standard deviation of x , and

s_y = sample standard deviation of y .

B. LINEAR REGRESSION

Regression analysis is a statistical procedure that is used to create an equation to explain how variables are related to each other. Simple Linear regression identifies how one variable, the dependent variable, behaves with a change in the independent variable (Anderson, et al., 2010, p. 530). More variables require the use of multiple regression models, which also increase the complexity of the model (Mendenhall & Sincich, 1996, p. 173).

A simple linear regression model is normally depicted as (Anderson, et al., 2010, p. 534):

$$\hat{y} = b_0 + b_1(x)$$

where

\hat{y} = is the estimate of the dependent variable based on the independent variable,

b_0 = where the trendline will intercept the y-axis if the independent variable is 0,

b_1 = the slope of the trendline, and

x = the independent variable that is being manipulated to understand the movement of the dependent variable.

1. Independent versus Dependent Variables

Simple linear regression analysis only takes two variables into account. The independent variable, typically depicted on the x-axis, affects the dependent variable, normally depicted on the y-axis (Mendenhall & Sincich, 1996, p. 93). For example, this model will measure how much y will increase or decrease when x increases or decreases. In this report, the dependent variable is normally depicted as a DoN expenditure, while the independent variable is the number of FTEs by appropriation, BSO, or hire type.

2. Coefficient of Determination

The coefficient of determination, abbreviated as R^2 in Microsoft Excel®, is a way to measure how well the regression equation fits the historical data that the equation was derived from (Anderson, et al., 2010, p. 545). R^2 values range from 0 to 1 with 0 meaning that the derived equation does not accurately model the data, and 1, which means the model derived will perfectly fit all provided data points and is thus the equation is a stronger model. R^2 is calculated in the following manner (Anderson, et al., 2010, p. 548):

$$R^2 = \frac{SSR}{SST} = \frac{\sum(\hat{y}_i - \bar{y})^2}{\sum(y_i - \bar{y})^2}$$

where

SSR is the Sum of Squares due to Regression and SST, is the Total Sum of Squares.

3. Multiple Regression

Simple linear regression is useful in understanding the relationships between two variables, but a single independent variable may not be the sole manipulator of the dependent variable. In order to understand how multiple variables can affect the dependent variable multiple regression analysis is needed (Anderson, et al., 2010, p. 613). A generic equation for samples looks like (Anderson, et al., 2010, p. 614):

$$\hat{y} = b_0 + b_1x_1 + b_2x_2 + \cdots + b_px_p$$

where

\hat{y} = the estimate of the dependent variable based on the independent variables

$$x_1, x_2, \dots, x_p.$$

For the purpose of this report, equations developed using this method will allow the use of multiple variables, such as the different hire types or appropriations, to be used in the determination of the DoN expenditures for civilian labor.

a. *Adjusted R^2*

The coefficient of determination R^2 is useful in simple linear regressions when there is only one independent variable. However, when additional independent variables are used in multiple regression analysis, the R^2 value will either remain the same or increase. Adjusted R^2 accounts for this increase and is thus a better tool to evaluate equations created using multiple regression. Similar to R^2 , the higher the Adjusted R^2 , the more the derived model will mimic the historical data from which it was calculated.

C. REGRESSION VALIDATION

Regression analysis uses historical data to develop equations that attempt to best explain the how a dependent variable will behave based on changes to one or more independent variables. These models, based on historical data, may then be used to predict future results, but only if the model is defensible.

1. *F-Statistic*

When analyzing simple linear regressions, R^2 is a useful tool in understanding how well the calculated equation reflects the collected historical data. Adjusted R^2 is used in the same way but for multiple regression analysis. Even though these are useful to evaluate models, the preferred method is to evaluate the significance of the F -statistic that is presented in Excel's regression readout. A lower value means that the probability that the regression was derived by chance is greatly reduced. A higher value calls into question the validity of the derived model (Mislick & Nussbaum, 2015, p. 138).

2. Probability (p) Value

The p -value is used when evaluating the different independent variables to determine how statistically significant they are to the model. A smaller p -value means that the probability that chance or randomness generated the values is low (Anderson, et al., 2010, p. 411). For this report, a confidence level of 90 percent has been adopted. Thus, α is 0.10 and any p -values above α will be removed from the model.

3. Multicollinearity

In this report, the independent variables may not be truly independent as there could be connections between the different variables. For example, a dramatic increase in GS FTEs may necessitate the hiring of an SES FTE in order to manage the new hires. Thus, GS and SES personnel are tied to each other. Multicollinearity is the test to determine the degree of independence these variables have from each other through the use of Excel's correlation function (Anderson, et al., 2010, p. 633). For the purpose of this report, values less than or equal to 0.3 are considered to be sufficiently independent from each other so as to not corrupt the model. Values 0.31 to 0.7 are in an area where multicollinearity may be present but may not adversely affect the results. Values 0.71 and above are considered highly suspect as the variables may be too dependent on each other (Mislick & Nussbaum, 2015, p. 159).

If multicollinearity is suspected, it is necessary to run the regressions both with and without the suspected variables. If both equations produce similar results, within 30 percent, then the multicollinearity does not present an issue and both equations are valid. However, if the tests are greater than 30 percent, then it is best to develop another model.

IV. METHODOLOGY

A. DATA SELECTION

Data on the civilian labor force and DoN expenditures was provided by FMB-423, Civilian Resources Division. Although defense spending has changed in various ways over the last century, the most recent ten years were particularly tumultuous period with numerous events that will most likely continue to shape budgets in the near future (Department of the Navy, 2017). Passage of the Budget Control Act in 2011 created the threat of sequestrations, frequent continuing resolutions (CRs) have impacted the predictability of federal budgets, and multiple other fiscal restraints have been added to defenses budgets, all of which are encompassed in the previous ten years. The use of data from additional years would only dilute the effects of these events by smoothing out the trends.

Since this report seeks to project the near-term future costs, where these external factors might still shape expenditures, it was important to ensure the effects are reflected as much as possible in future projections.

B. DATA PREPARATION

1. Normalization

The data provided by FMB-423 was in Then Year Dollars (TY\$) and needed to be adjusted for inflation to provide dollar figures in Constant Year (CY\$) amounts. To adjust TY dollars into CY dollars, the Naval Center for Cost Analysis (NCCA) was used. NCCA captures the inflation values for past, present, and future budgets and has created the Joint Inflation Calculator (JIC), which allows normalization of data. By taking the original data and then adjusting for inflation to a common year, in this report FY 2017, constant (or real) dollar values adjust for the change in purchasing power of the dollar over time, allowing a comparison of dollar values from one year to another. The result of the constant dollar transformation is an accurate comparison of the growth in expenses due to cost growth and not as a result of inflation.

2. Data Organization

The original data was then divided in three ways:

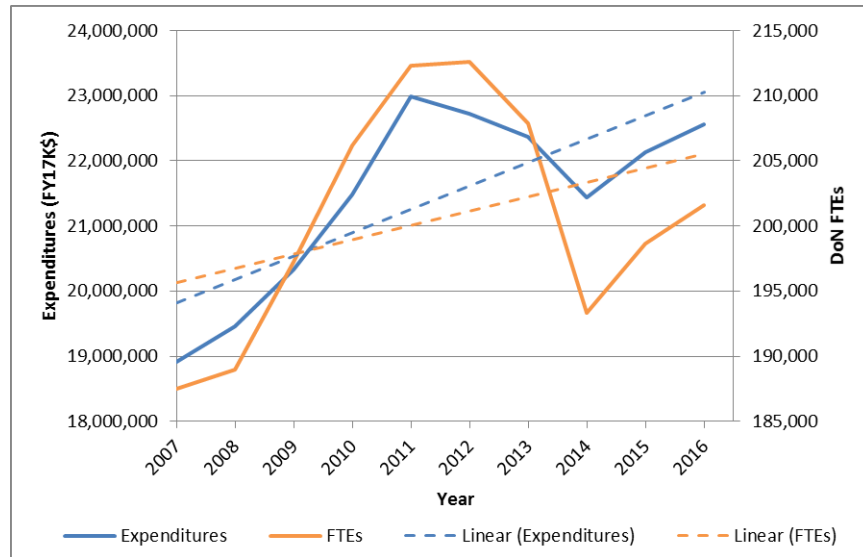
- By Hire Type to better see the trends in the workforce and pay systems
- By Appropriation to better see which appropriations were growing in both expenditures and FTEs
- By BSO to see which organizations were growing in expenditures and FTEs

In each of these three categories, the data was further subdivided into years to allow a more detailed analysis of the trends. After subdividing the data, the individual amounts were totaled in order to create a denominator to use in the calculation of percentages.

To understand the changes in the Civilian Labor Force, 2007 was used as the base year from which all changes would be measured. This information was presented first and then the changes up to 2016 were discussed to show how FTE numbers and expenditures changed over the period. Initially, 2017 data was to be used as the final year. However, the data was collected in January of 2017 and subsequent changes to the DOD budget and changes in funding for FY17 made this data highly suspect.

3. Simple Linear Regression Creation and Validation

After reorganizing the data and making initial calculations, Excel's line chart function was used to visually represent the data in an easily digestible form, similar to the graphs seen in Figure 1. Excel's regression function was then used to create the simple linear equations to create a model that mimics the growth of data from 2007 to 2016.



Adapted from C. Greaver, non-archived email, January 27, 2017.²

Figure 1. Changes of DoN Civilian FTEs and Expenditures, 2007–2016.

The simple linear model was then validated by looking at the R^2 value. Any values less than 0.75 meant that the regression equation created did not accurately model the historical data and could not be used as a defensible model to predict trends in the future. Even though the R^2 values of 0.59 for expenditures and 0.13 for FTEs mean the developed equation is not defensible, it does highlight that, on average, the expenditures for civilian labor are growing at a faster rate than the civilian workforce. In some cases, the simple linear regression equation could not be used so more detailed multiple regression models would be necessary.

4. Multiple Regression Model Creation and Validation

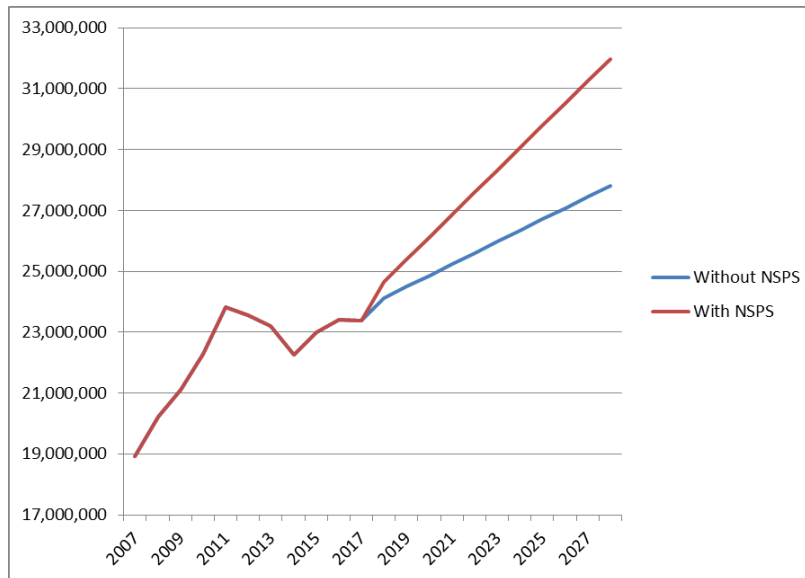
Although the total number of FTEs is the primary driver of total expense, the different FTEs grew at different rates indicating that a multiple regression model that took into account the changes in the different hire types may produce a more accurate model.

² The information on civilian labor and associated costs came from the OP08 database maintained by the U.S. Navy. The information is accessible to certain individuals and Mr. Greaver of FMB-423 provided the author the data from 2007-2017.

An initial model was developed using total expense as the dependent variable and the total number of the different hire types as the independent variables. The resulting model was a poor fit as the Significant F -value of 0.34 and the p -values³ for each of the independent variables was above the predetermined α of .10, although model fit, as determined by the adjusted R^2 , was 0.76. With so many independent variables, it was necessary to ensure that the independent variables had sufficient independence from each other. Using Excel's correlation function, there were variables that were highly correlated with each other but no logical reason could be discerned for this outcome. Since there was no logical reason for this result, the values remained in the equation.

One issue that did come from initial analysis was that the NSPS hire type skewed the results even though the NSPS hire type was discontinued and would not play a factor in future expenditures. In order to correct for that discrepancy, subsequent models were created without the NSPS hire type included in the regression. Figure 2 demonstrates how much the inclusion of the NSPS data could skew a future prediction of growth with the burgundy line predicting future growth using NSPS data and the blue line showing predictions after the NSPS hire type was removed as an independent variable.

³ p -Values for each of the independent variables ranged from 0.442 to 0.947



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 2. Difference between Predictions with and without NSPS Hire Type.

The regression created by using the growth of different FTEs in the DoN was not defensible due to the multiple independent variables having large p values as well as the Significant- F result of the regression equation. Since this approach would not produce defensible results, it was necessary develop a different method for predicting DoN labor costs with respect to personnel.

The first subdivision of the Navy is into the individual BSOs. These individual BSOs expanded and contracted at different rates. Organizations like BSO 60, U.S. Fleet Forces (USFF), and BSO 70, U.S. Pacific Fleet (PACFLT), experienced explosive growth while others like BSO 18, The Bureau of Medicine, contracted. Not only did the individual BSOs expand and contract at various rates, the increase or decrease of the individual hire types within the BSOs themselves varied dramatically with some hiring more DP FTEs and other hiring more GS FTEs.

In order to better capture these trends, it was necessary to create simple linear regressions of each hire type in individual BSOs and then create a projected growth of each BSO. Then the totals of each BSO were combined to create a total DoN growth

projection. This updated projection almost exactly matched the first model but did provide more insight into the behaviors of the different BSOs and the trends of hire types in the subunits.

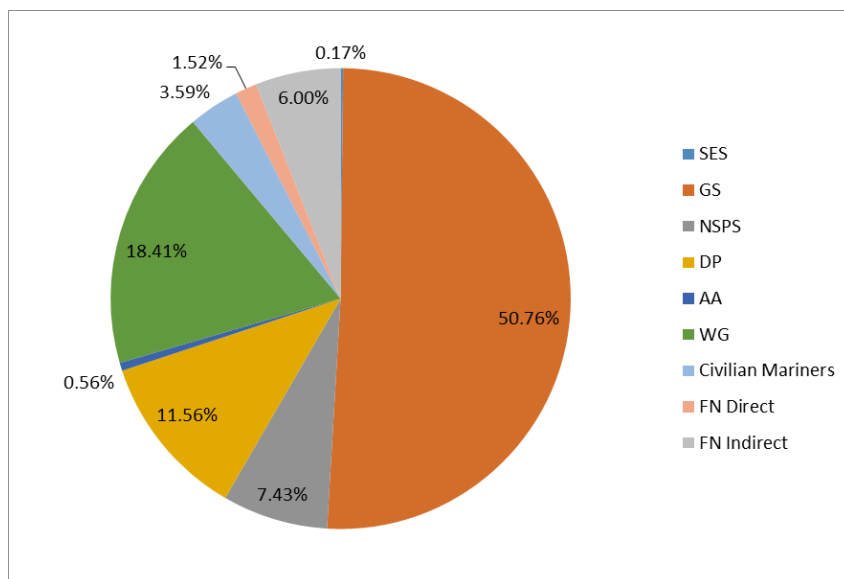
V. CALCULATION OF CIVILIAN LABOR COSTS

A. CIVILIAN LABOR FORCE OVERVIEW IN 2007

In 2007, the DoN employed 187,641 civilian FTEs at a cost of \$18,917,892,000⁴ (FY17\$). This figure means that the DoN paid an average of \$100,916.42 per FTE, or \$48.52 per man-hour.⁵

1. Civilian Labor Breakdown by Hire Type

In 2007, 51 percent of the DoN FTEs were General Schedule (GS), at a total expense of \$10,147,380,000, approximately 53.64 percent of all DoN expenditures on civilian labor (Figure 3). Wage Grade (WG) civilians were the second largest group of FTEs, at 18.41 percent at a cost of \$3,045,514,000, 16.10 percent of all civilian labor expenditures.



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 3. 2007 Breakdown of Civilian FTEs by Hire Types.

⁴ Unless specified, all dollar values have been normalized to FY 2017 values.

⁵ Since 2007 was not a leap year, the amount of man-hours per FTE was calculated at 2,080.

Even though GS and WG were the most numerous hire types requiring the most funds, they were not the most expensive hire types per FTE. SES, were the most expensive FTE, costing an average of \$222,033.17 per FTE, or \$106.75 per man-hour (Table 1). Even though this amount is 120 percent more than the DoN average of \$100,916.42, the SES hire type was only a total of 327 FTEs and accounted for 0.17 percent of all FTEs in 2007.

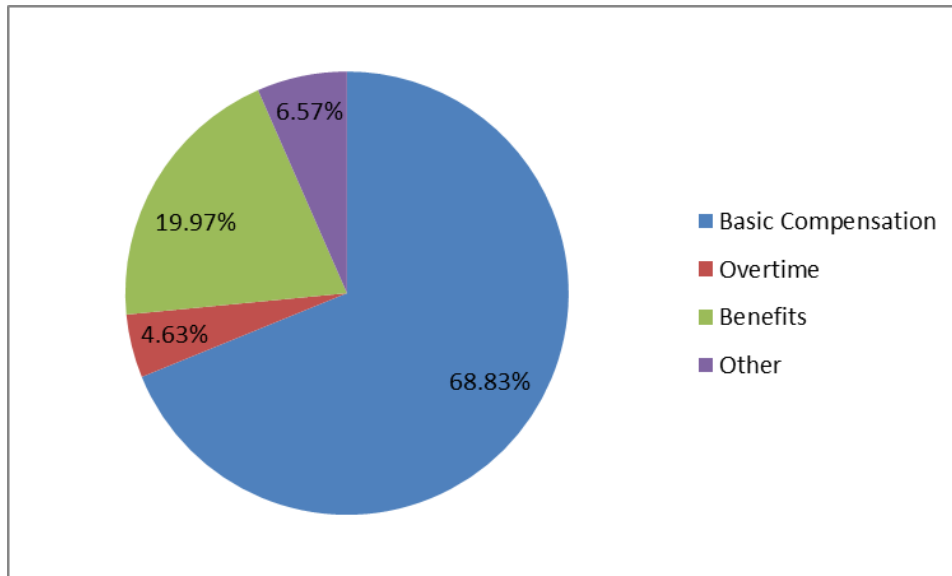
Table 1. Dollars per FTE and Man-Hour in 2007.

	Dollars per FTE	Cost per Man-Hour
Senior Executive Service	\$ 222,033.17	\$ 106.75
General Schedule	\$ 106,630.45	\$ 51.26
NSPS	\$ 122,631.00	\$ 58.96
Demonstration Project	\$ 136,323.99	\$ 65.54
Administrative Action	\$ 174,232.32	\$ 83.77
Wage Grade	\$ 88,265.52	\$ 42.44
Civilian Mariners	\$ 79,733.85	\$ 38.33
Foreign National Direct	\$ 51,286.95	\$ 24.66
Foreign National Indirect	\$ 11,045.72	\$ 5.31

The above table shows the average cost per FTE and per Man-Hour for each hire type in 2007. Adapted from C. Greaver, non-archived email, January 27, 2017.

2. Civilian Labor Compensation Breakdown

In terms of Civilian Labor Compensation, the majority of funds, 68.83 percent of all labor costs, were expended providing Basi Government Accountability Office Compensation to the civilians as seen in Figure 4. The second largest component, at 19.97 percent of all labor costs, was the payment of benefits. Overtime was third largest single category at 4.63 percent of all compensation costs and was most prevalent in the NWCF appropriations.



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 4. 2007 Total Civilian Labor Cost Breakdown.

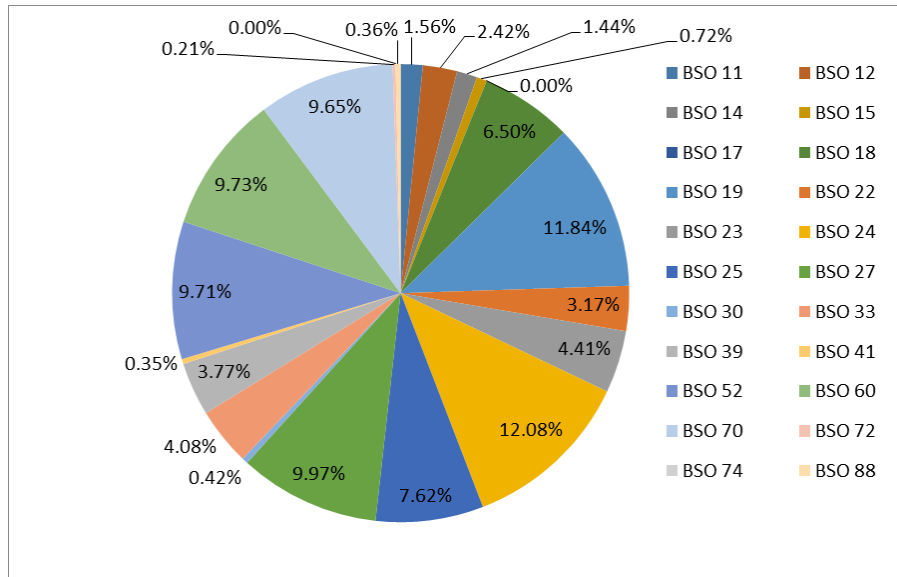
Other expenditures was actually larger than overtime at 6.57 percent but this category is actually a combination of all the other payments made to the various items such as awards, pay pool, Permanent Change of Station (PCS), voluntary separation, and early retirement, which themselves are a very small percentage individually, 1.8 percent or less.

3. Civilian Labor Force Break Down by BSO

The previous two sections discussed the composition of the civilian labor force and the structure of their compensation. One item to note is that the civilian labor force of the individual BSOs changed in the 2007–2016 period and understanding the changes will help provide understanding to the changes in the DoN Civilian Labor Force.

In 2007, 12.08 percent of DoN FTEs were in Naval Sea Systems Command (NAVSEA), BSO 24, and 11.84 percent were in Naval Air Systems Command (NAVAIR), BSO 19. These two BSOs accounted for 15.61 percent and 13.53 percent, respectively, of total DoN civilian labor expenditures in 2007. However, BSOs 24 and 19 did not spend, on average, the most per FTE as BSO 14, Chief of Naval Research, and

BSO 39, Space and Naval Warfare Systems cost \$139,047.85 and \$133,764.07 per FTE, respectively (Figure 5).



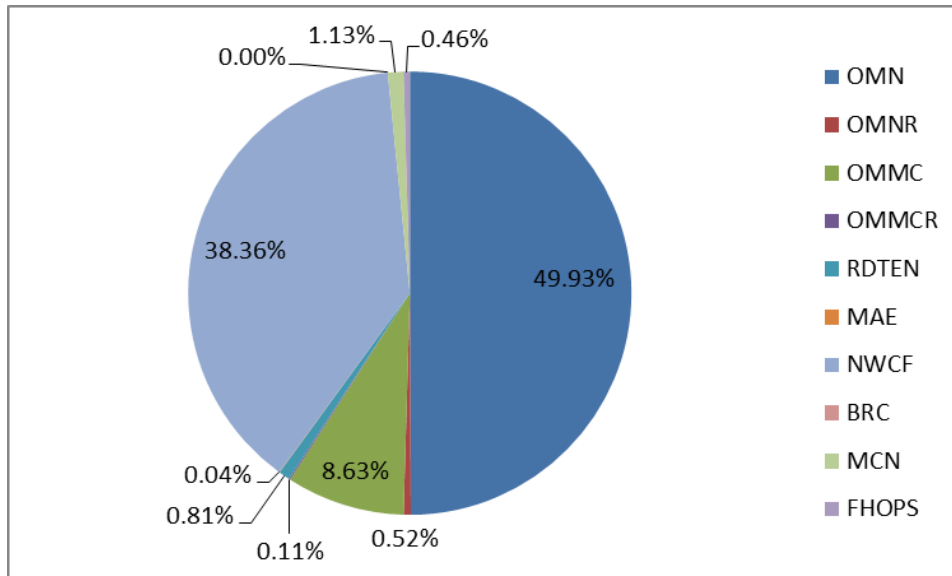
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 5. 2007 Breakdown of Civilians FTEs by BSO.

The reason for the increased expense of an FTE in BSO 14 and BSO 39 when compared to NAVSEA and NAVAIR is that the first two BSOs employed more of the relatively expensive NSPS and DP hire types whereas the other BSOs mainly employed the less expensive GS hire type.

4. Civilian Labor Force Break Down by APPN

The final way to evaluate the composition of the Civilian Labor Force is to see how the FTEs are divided among the different APPN categories, as displayed in Figure 6.



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 6. 2007 Breakdown of Civilians by Appropriation.

In 2007, 49.93 percent of the civilian personnel fell under the appropriation labeled as Operations and Maintenance, Navy (OMN). The cost of the OMN civilians is \$9,249,369,000, or 48.89 percent of total labor costs. The majority of the FTEs employed in OMN, 60.59 percent, were GS with the second largest hire type in OMN was WG FTEs at 19.27 percent. While the GS FTE is more expensive than the DoN average of \$100,916.42 per FTE, it was only slightly so (Table 1). WG FTEs were less expensive than the DoN average.

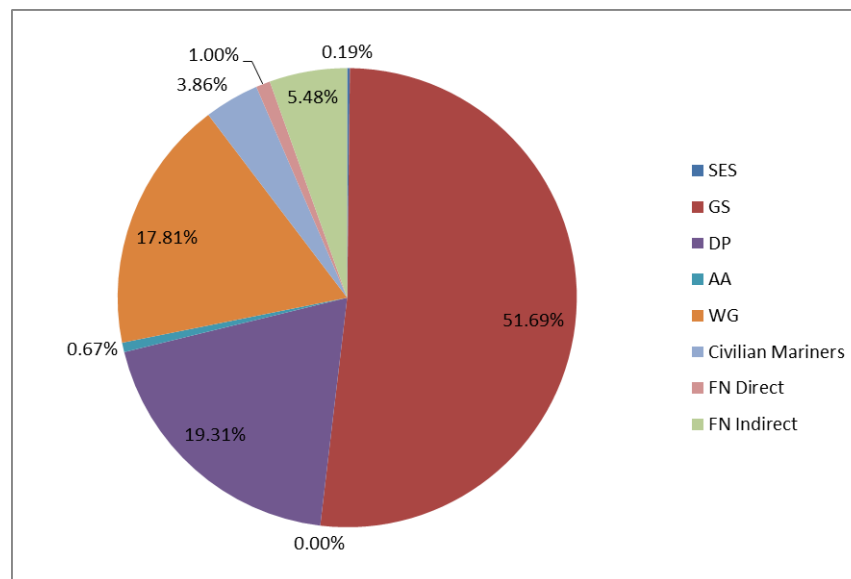
The Navy Working Capital Fund (NWCF) was the second largest appropriation at 41.49 percent of total labor costs at \$7,849,958,000 but only 38.36 percent of the Navy's civilian FTEs. The GS FTE was also the most numerous hire type in the NWCF appropriation at 35.19 percent of the labor force. The second largest hire type was the more expensive DP hire type at 28.84 percent of the NWCF APPN labor force. The next two largest hire types were the WG FTEs at 19.19 percent and Civilian Mariners at 9.31 percent.

B. CHANGES IN THE CIVILIAN LABOR FORCE FROM 2007 TO 2016

In 2016, the DoN employed 201,581 civilian FTEs at a cost of \$22,552,748,000. This figure means that the DoN paid an average of \$111,879.34 per FTE, or \$53.58 per man-hour.⁶ Compared to 2007, this means that the number of FTEs grew 7.53 percent while the total expenditures on labor grew by 19.21 percent. During this period, the cost per FTE grew 10.86 percent. As shown in Figure 1, the DoN saw changes in the number of civilian FTEs employed and the total amount spent for civilian labor during the period 2007–2016.

1. Changes in Civilian Labor by Hire Type

In 2016, 51.69 percent of the DoN FTEs were GS, a total expense of \$12,357,657,000, approximately 52.76 percent of all DoN expenditures on civilian labor (Figure 7). Demonstration Project (DP) increased from 11.56 percent of the civilian labor force to 19.31 percent of the labor force to become the second largest hire type. This is a notable change in the composition of the civilian labor force considering that DP FTEs are an expensive hire type at \$146,444.39 per FTE, or \$70.14 per man-hour (Table 2).



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 7. 2016 Breakdown of Civilian FTEs by Hire Types.

⁶ Unlike 2007, 2016 was a leap year so the amount of man-hours per FTE was calculated at 2,088.

Wage Grade (WG) civilians shrunk to 17.81 percent of the labor force to become the third largest group of FTEs.

Table 2. Dollars per FTE and Man-Hour in 2016.

	Dollars per FTE	Cost per Man-Hour
Senior Executive Service	\$ 238,908.11	\$ 114.42
General Schedule	\$ 118,609.22	\$ 56.81
Demonstration Project	\$ 146,444.39	\$ 70.14
Administrative Action	\$ 172,950.76	\$ 82.83
Wage Grade	\$ 89,487.29	\$ 42.86
Civilian Mariners	\$ 103,263.61	\$ 49.46
Foreign National Direct	\$ 54,522.92	\$ 26.11
Foreign National Indirect	\$ 13,975.78	\$ 6.69

The table shows the average cost per FTE and per man-hour for each hire type in 2016. Adapted from C. Greaver, non-archived email, January 27, 2017

Appendix A shows the changes in the number of the different civilian FTEs in the DoN from 2007 to 2016. In this period, the NSPS hire type was discontinued and there were decreases in the two relatively inexpensive Foreign National Hire Types, when compared to the average cost for a DoN civilian FTE. On average, all other hire types in the DoN saw growth with the largest growth in terms of numbers, 17,254, and rate, 79.60 percent, being DP FTEs.

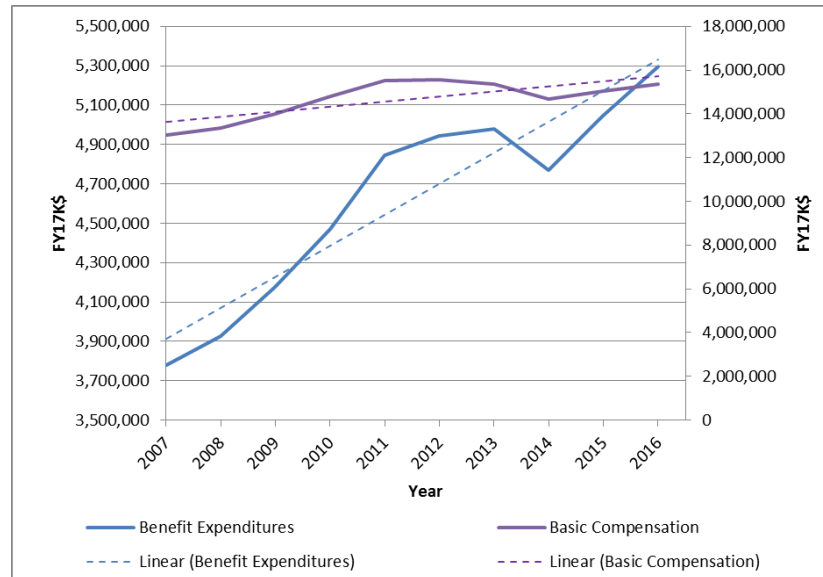
2. Changes in Civilian Labor Compensation

From 2007 to 2016, the DoN increased spending on Civilian Labor by \$3.6 Billion. Most of the increase in civilian labor costs went into Basic Compensation, which grew 18.12 percent from 2007. However, it should be noted that expenditures for benefits grew 40.14 percent during the same period.

Figure 8 serves to show the difference in the growth rates between Basic Compensation and Benefits costs from 2007 to 2016. The regressions⁷ depicted on the

⁷ The equation for the trend line for Total Basic Compensation Expenditures is $y=233,486x+10,000,000$ with a R^2 of 0.59 and $y=158,055x+4,000,000$ with a R^2 of 0.88 for Total Benefits Expenditures.

graph closely follow the actual data and demonstrate how much more rapidly the cost of benefits is growing when compared to the growth of Basic Compensation.

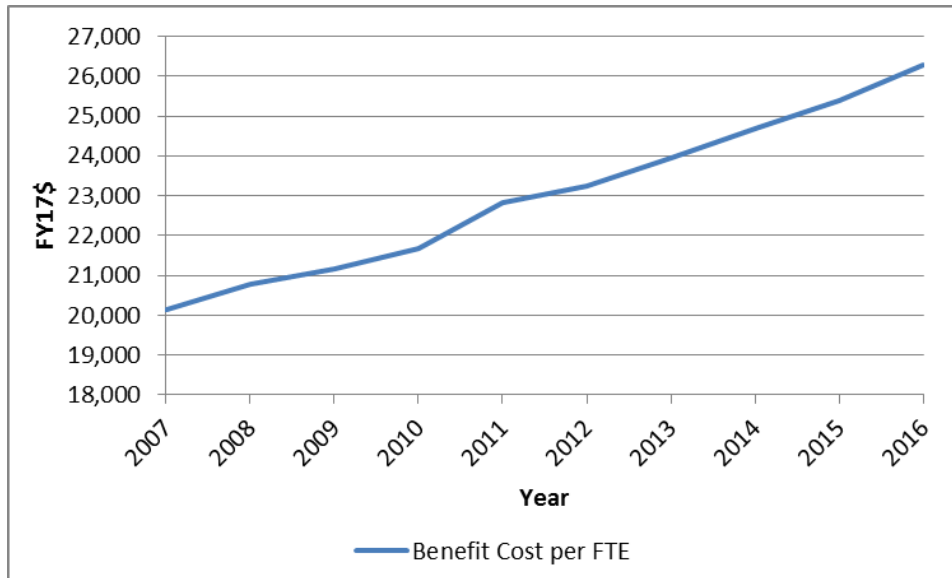


Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 8. Comparison in the Growth of Basic Compensation and Benefits, 2006–2017.

Figure 9 shows that, in terms of benefits expense per FTE, the average expense grew over \$6,000 from \$20,153.55 in 2007 to \$26,265.23 in 2016, an average of 3 percent per year.⁸

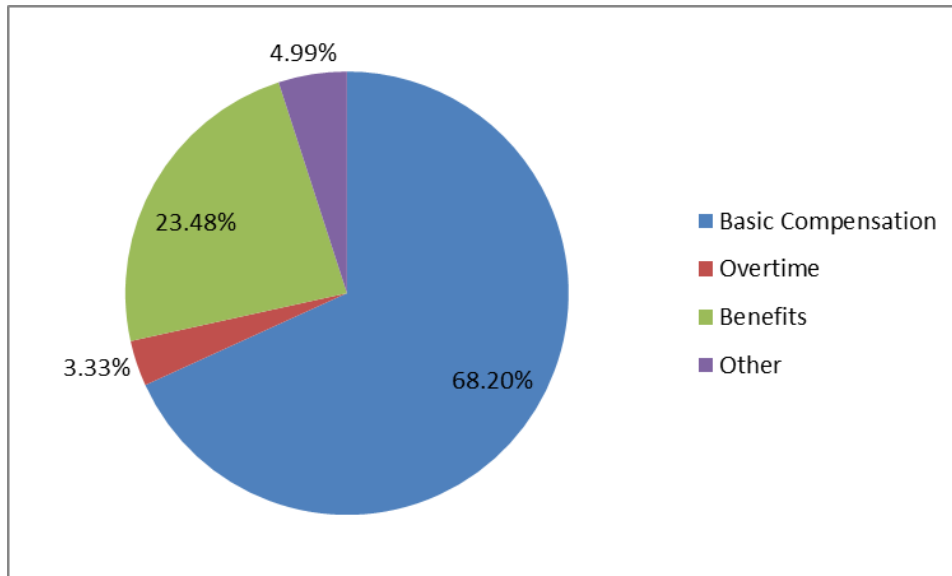
⁸ The regression equation for Benefit Expense per FTE is $y=695.94x+19,374$ with a R^2 of 0.995



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 9. Changes in Benefit Expense per FTE, 2007–2016.

When looking at total civilian compensation expenditures, benefit expenses grew from 19.97 percent to 23.48 percent of all labor costs (Figure 10). In 2007, the DoN spent, for the average FTE, \$69,463.16 on Basic Compensation and \$20,153.55 on Benefits. In 2016, the DoN spent \$77,247.79 in basic compensation for the average FTE and \$26,484.36 on benefits expense.

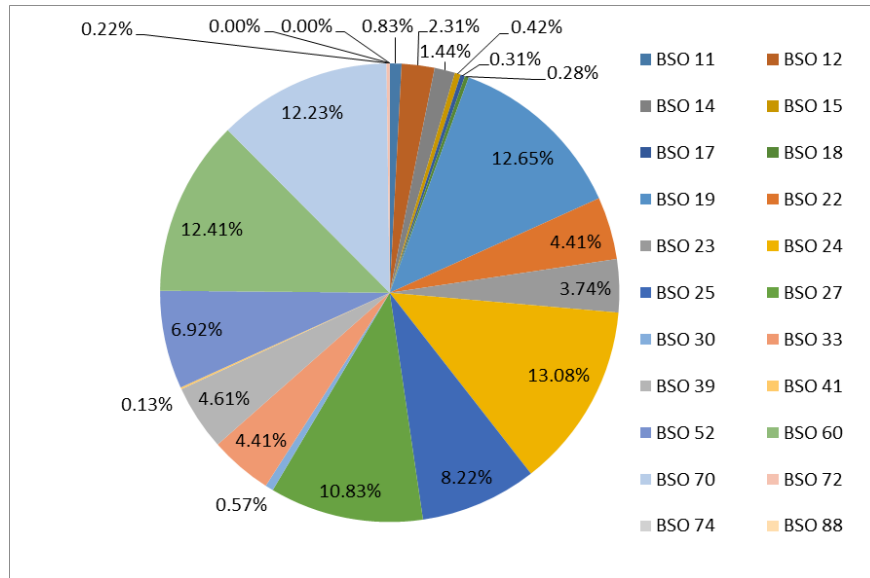


Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 10. 2016 Total Civilian Labor Cost Breakdown.

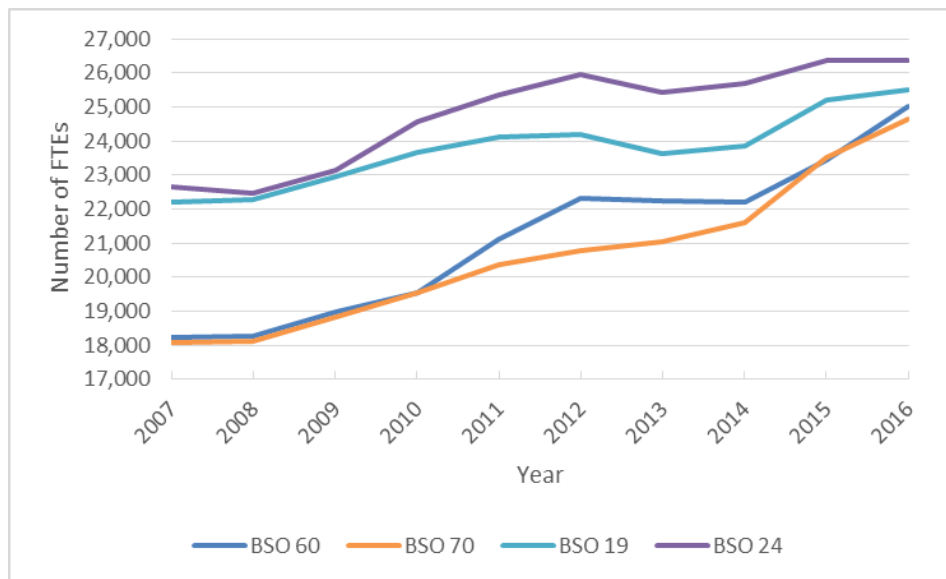
3. Changes in the Civilian Labor Force by BSO

In 2016, the largest BSOs were NAVSEA, BSO 24, and NAVAIR, BSO 19 with 13.08 percent and 12.65 percent, respectively, of the civilian FTEs (Figure 12). Notably USFF, and PACFLT, grew to 12.41 percent and 12.23 percent of the civilian labor force (Figure 11). These four BSOs contained 50.37 percent of all DoN civilian FTEs and accounted for 51.39 percent of all civilian labor expenditures. Figure 12 serves to highlight the rapid growth of FTEs in USFF and PACFLT when compared to NAVSEA and NAVAIR.



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 11. 2016 Breakdown of Civilian FTEs by BSO.



Adapted from C. Greaver, non-archived email, January 27, 2017.

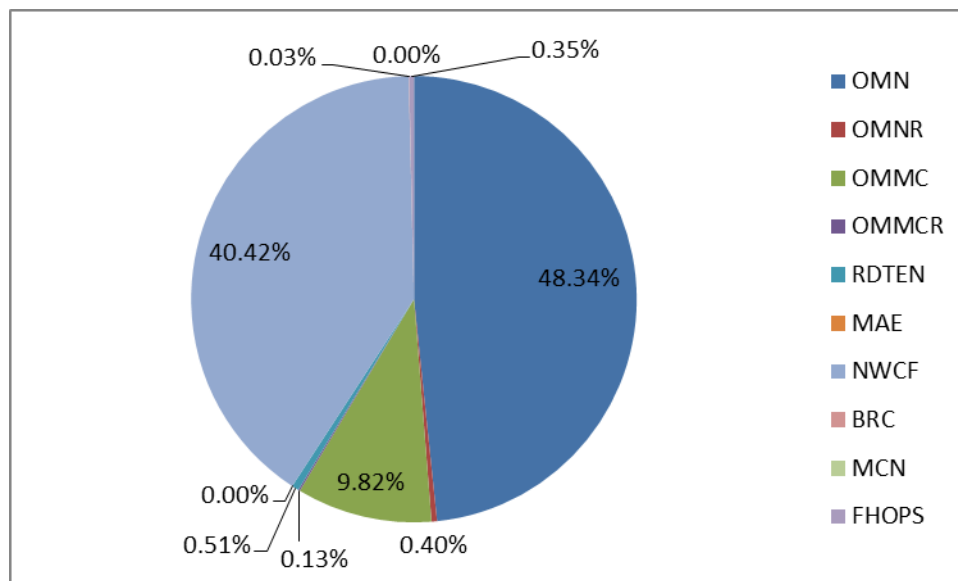
Figure 12. Growth of Four Largest BSOs, 2007–2016.

In this period, USFF added 6,701 GS FTEs and 4,100 WG FTEs. PACFLT added 4,383 GS and 3,319 WG FTEs. In terms of cost per FTE, the average GS FTE is

approximately \$6,000 more expensive than the average DoN FTE and WG FTEs are approximately \$23,000 cheaper (Table 2).

4. Civilian Labor Force Break Down by APPN

In 2016, three appropriations, OMN, OMMC, and the NWCF comprised 98.58 percent of all civilian FTEs (Figure 13). Since 2007, the largest increases in civilian FTEs were found in two appropriations: the Navy Working Capital Fund (NWCF) with the addition of 5,908 FTEs growing from 29.08 percent to 30.73 percent of all DoN civilian FTEs. Operations and Maintenance, Navy and Marine Corps grew 3,843 and 3,619 FTEs, respectively. The majority of these FTE increases were in the GS and DP hires in the NAVAIR and NAVSEA BSOs. In terms of average cost per FTE, the appropriation category with the largest increase was RDTEN with a 42.42 percent increase since 2007 despite shrinking from 1,520 FTEs to 1,027; a cut of 493 FTEs.



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 13. 2007 Breakdown of Civilians by Appropriation.

One explanation for this increase in expenditures in the RDTEN Appropriation can be the 23.12 percent increase in spending by BSO 14, the 16.98 percent increase by

BSO 18, and BSO 41, which in 2007 had not funded any civilian FTEs but in 2016 accounted for 25.62 percent of funding.

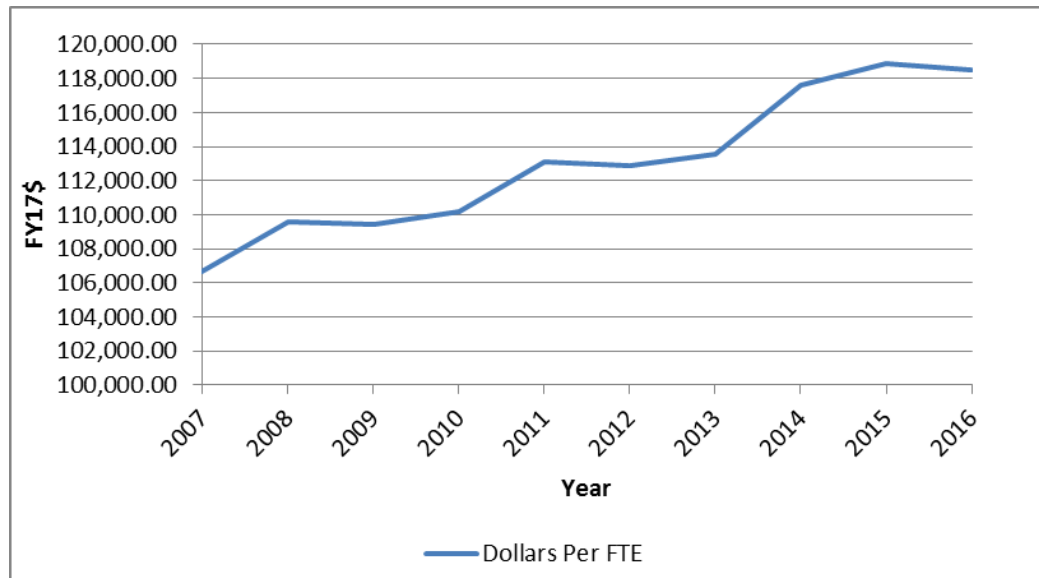
Another explanation can be the increase in the use of DP FTE's by BSO 14, which accounted for 46.81 percent of expenditures whereas in 2007 BSO 14 did not fund any DP personnel. DP personnel cost, on average, \$146,444.39 per FTE, which is over \$30,000 more per year than the average DoN FTE.

5. Changes in the Cost per FTE

Using the data provided by FMB-423, the average cost per FTE can be calculated by dividing the total expenditures by the number of FTEs to come up with the amount required to purchase one FTE. In 2007, to support one FTE for the year cost the DoN \$100,916.42. In 2016, the cost to support one FTE rose by \$12,009.77 to \$112,926.19; an 11.90 percent increase. Using this information, it can be estimated that the DoN can expect to see an increase in the cost of an average DoN FTE by 1.07 percent per year (Figure 14).

The cost per FTE growth can be attributed to the reduction in number of relatively inexpensive FTEs, such as Indirect Foreign Hires, and the addition of more expensive hire types such as GS and DP FTEs. When constructing the linear trendline,⁹ the correlation coefficient, R^2 , is 0.94 percent, which strongly suggests this is a viable equation that can be used to project the growth in the cost per FTE in the near future.

⁹ The equation for the trendline is $Cost\ per\ FTE = 1,346.4x + 105,626$ where x is the year (2007 = 1, 2008=2, etc.)



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 14. Growth in the Cost per FTE, 2007–2016.

C. CIVILIAN LABOR CHANGES SUMMARIZED

Figure 14 serves to highlight that the cost per average FTE has increased at a steady rate from 2007 to 2016. During that same period, civilian basic compensation saw a modest increase of 11 percent and remains the dominant portion of civilian labor expenses. In the same timeframe, expenditures on benefits for the typical FTE grew three times faster than basic compensation to become a larger portion of overall compensation.

Changes were seen in the different BSOs with some BSOs, like Bureau of Medicine, showing a decrease in personnel and associated costs due to organizational changes. In contrast, USFF and PACFLT saw growth that put them almost on par, in terms of number of FTEs, with the two largest BSOs, NAVAIR and NAVSEA. At the end of 2016, NAVAIR, NAVSEA, USFF, and PACFLT were the four largest BSOs in the DoN and this trend will most likely continue as BSO 33, Military Sea Lift Command, with over 8,000 FTEs, is incorporated into USFF.

With few exceptions, each of the hire types saw some growth. The most growth in terms of numbers and rate of growth was seen in the more expensive DP hire type followed by GS FTEs. Some of the changes in the different hire types can be explained

by the transfer of personnel previously under the NSPS designation to other systems but the changes in the number of FTEs in the DoN and in the individual BSOs varied over the period. These variations in the number of FTEs will make it difficult to create any meaningful predictions in future years.

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VI. PROJECTION OF FUTURE CIVILIAN LABOR COSTS

A. MODELING THE CHANGES IN THE DON

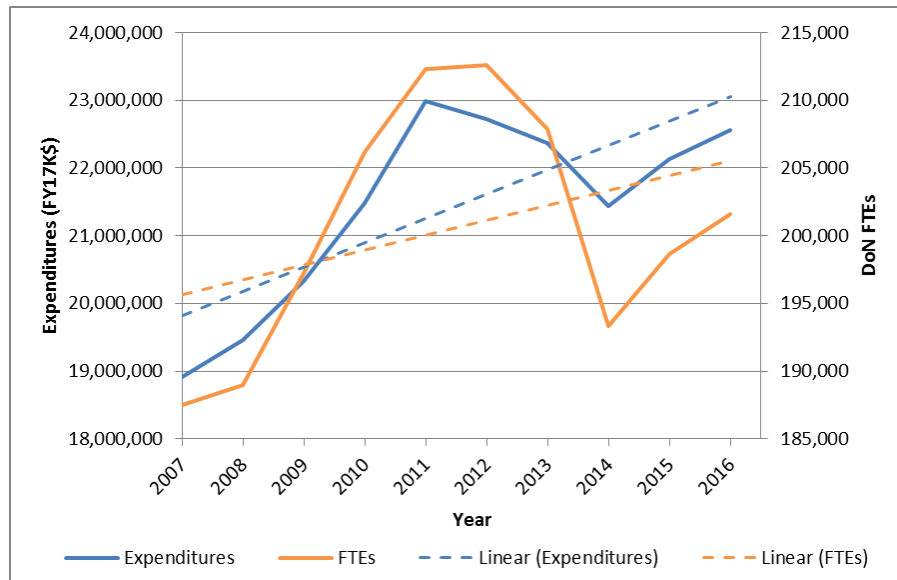
1. Linear Regression Models for the DoN

Figure 15 shows the historical data with the solid blue line representing the growth of DoN expenditures on civilian labor and the solid red line representing the number of DoN FTEs, measured on the right y-axis. The dashed blue and red lines are visual representations of the linear regression equations that Excel has created for the expenditures and FTEs respectively. The regression equations and associated R^2 values are

$$\text{Total Expenditures} = 360,072x + 20,000,000 \quad R^2: 0.589$$

$$\text{Total FTEs} = 1,093.9x + 194,585 \quad R^2: 0.134$$

where x is the year for which the FTE or expenditure is to be calculated using sequential values (i.e., $x = 1$ for 2007, $x = 2$ for 2008, ..., $x = 12$ for 2018, etc.)



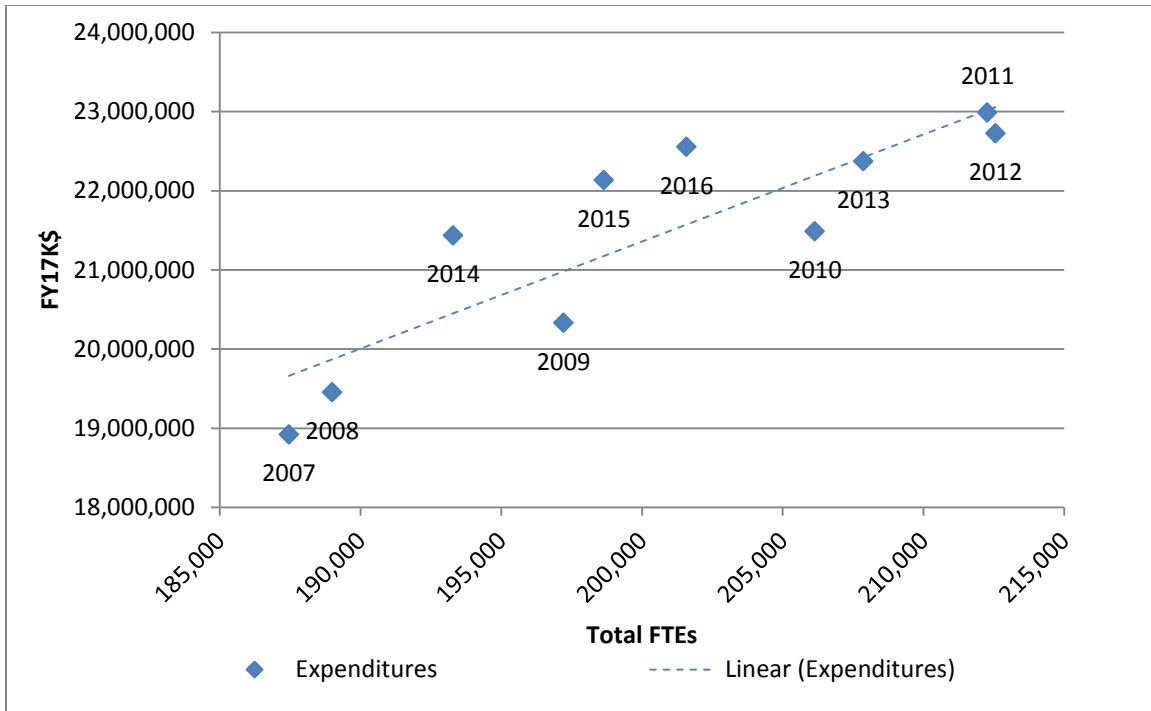
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 15. Changes of DoN Civilian FTEs and Expenditures, 2007–2016.

Once the regression calculations are complete, it is necessary to evaluate the strength of the linear models by evaluating their associated R^2 values. R^2 values show how closely regression equations model the historical data from which they are derived. Ranging from zero to one, the higher the R^2 value, the closer the derived equation will model the historical data. The lower the R^2 value, the less the derived equation models the historical data.

The regression equation for total expenditures from Figure 15 explains 59 percent of the variation of the historical data, but the regression model for FTEs has very poor explanatory power with an R^2 of 0.13. Since the R^2 values for both regression equations are below 75 percent, they would be unacceptable to use for creating projections due to the large variations seen. Even though the equations cannot be used for creating a defensible projection of expenditures or FTEs, they can be useful for evaluating general trends.

In Figure 15, the independent variable was time and the dependent variables were expenditures and total number of FTEs. Since time is usually a poor independent variable, another approach to finding total expenditures is to make FTEs the independent variable. In this manner, it is possible to see how total expenditures will change following a change in the total number of FTEs. To test this proposition, the total number of FTEs replaced time on the x-axis and total expenditures remained on the y-axis as the dependent variable (Figure 16).



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 16. Changes in Expenditures with Changes in Total Number of FTEs, 2007–2016.

Figure 16 is a scatter plot diagram where the total number of FTEs is the independent variable on the x-axis and total expenditures is the dependent variable on the y-axis. Each year of the historical period is placed as a point on the graph and then the following regression equation and associated R^2 value was derived:

$$\text{Total Expenditures} = 135.43 * \text{Total Number of FTEs} - 6,000,000 \quad R^2: 0.746$$

Rounded up to 0.75, the equation's R^2 value means that the derived equation closely matches the historical data. Since the R^2 value is equal to the predetermined threshold, it means that the equation can be defended as a method for determining a future total expenditure based on the total number of civilian FTEs.

Even though a defensible model for calculating total DoN expenditures is possible, Figure 15 shows that linear regression would not be accurate enough to determine the total number of DoN civilian FTEs.

Instead of trying to calculate the total number of DoN civilian FTEs using one regression, an alternative approach was undertaken where linear regressions were derived for each of the hire types. It was postulated that in this manner, it would be possible to create defensible regressions that could be combined to create a total DoN FTE estimation. Changes in different hire types were evaluated from 2007–2016 and regression equations were derived using Excel (Appendix A). The regression equations and their associated R^2 values are

$$\text{Total AA FTEs} = 34.758x + 1051.3 \quad R^2: 0.61$$

$$\text{Total Civilian Mariner FTEs} = 145.78x + 6787.5 \quad R^2: 0.7$$

$$\text{Total DP FTEs} = 2822.8x + 13985 \quad R^2: 0.8$$

$$\text{Total FND FTEs} = -85.376x + 2864.7 \quad R^2: 0.8$$

$$\text{Total FNI FTEs} = 27.164x + 11141 \quad R^2: 0.04$$

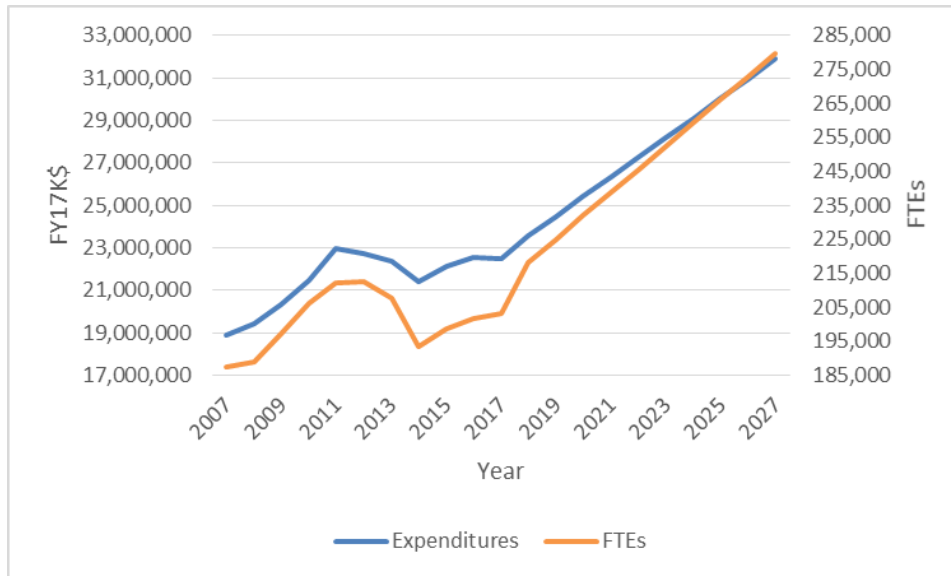
$$\text{Total GS FTEs} = 3845.3x + 72555 \quad R^2: 0.33$$

$$\text{Total SES FTEs} = 1.8182x + 351.2 \quad R^2: 0.04$$

$$\text{Total WG FTEs} = 57.036x + 34152 \quad R^2: 0.06$$

where x is the year for which the FTE is to be calculated using sequential values (i.e., $x = 1$ for 2007, $x = 2$ for 2008, ..., $x = 12$ for 2018, etc.)

Using the above equations for each hire type, combining the individual results to create a total number of FTEs, and then inserting the combined total into the equation for total expenditures that was previously derived, resulted in the projection shown in Figure 17.



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 17. Projected DoN Expenditures When Predicting Changes in FTEs, 2018–2028.

Figure 17 represents the growth of DoN expenditures on civilian labor after projecting the changes in each of the DoN FTE hire types. If the factors and trends that shaped the historical data remain true, the DoN can expect to spend a total of \$277,290,505,000 on civilian labor in the period 2018–2028. Even though this projection is an improvement over the first attempt to calculate total expenditures, the independent variable is derived using eight linear regressions, of which only two have a defensible R^2 .

A linear regression model of the total number of DoN FTEs as well as a second attempt which combined the regression models of each hire type both proved inadequate to develop a suitable model for projecting future DoN expenditures on civilian labor. A third avenue to attack this issue was to evaluate the changes in FTEs of the individual BSOs to create defensible projections, which could then be combined to create a total number of FTEs. After calculating a total number of FTEs an estimation of total expenditures can be developed using the equation derived from Figure 16 (Figure 18).



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 18. Changes in Total FTEs and Expenditures, 2007–2028, Accounting for BSO Trends.

Figure 18 shows the projected number of FTEs and total expenditures when accounting for FTE trends in the individual BSOs (Appendix B). Using this information, the DoN is projected to add an additional 27,541 FTEs from 2018 to 2028 and spend a total of \$261,686,602,000 over the same period.

Even though this third attempt is better than the previous models for calculating total expenditures based on FTEs, it is still not a defensible projection. Of the 20 BSO regressions created to develop the total FTE projection, only nine had R^2 values that passed the predetermined threshold of 0.75. Due to the variability in FTE projections, another method of projecting the total number of FTEs must be developed.

A final method involved using linear regression models to predict the growth of the individual hire types in each BSO and then combine those results to create a projection of total FTEs in the BSO. All the BSO totals were then combined to create a total DoN FTE number that was then inputted into the expenditure equation derived from Figure 15 to project total expenditures. This approach proved unfruitful because of the

107 regressions created for each hire type in the individual BSOs, only 18 equations had defensible R^2 values. Because only 16 percent of the regression equations could be used to calculate total expenditures, this method was not pursued as the previous attempt had 45 percent of the regressions being viable.

Using linear regressions or combining linear regressions did not provide defensible projections but using multiple regression models may allow the creation of models that only use the previously derived defensible equations to create projections.

2. Multiple Regression Models for the DoN

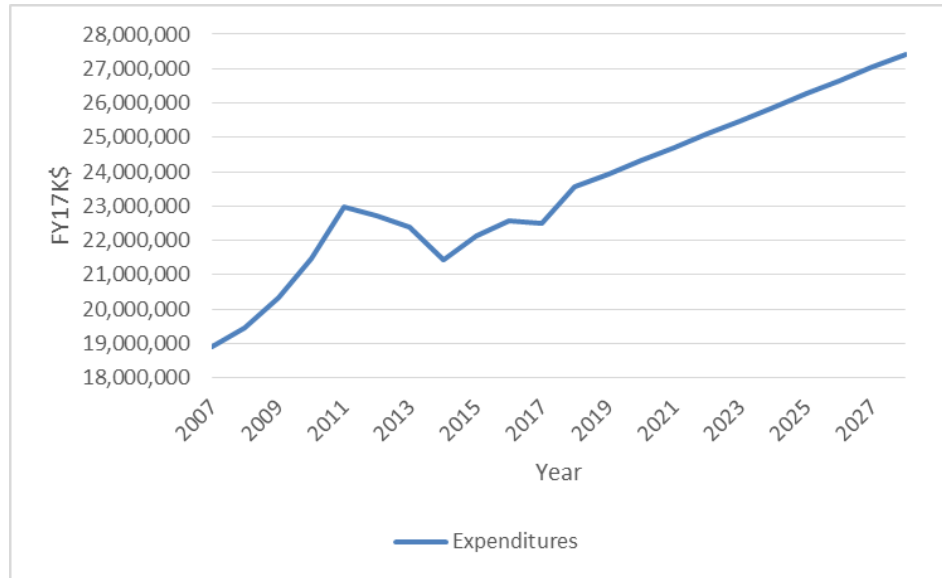
Since simple linear regression models could not produce a defensible projection of DoN FTEs, it was postulated that using multiple regression techniques to derive expenditures and FTEs would create projections that could withstand scrutiny.

The first attempt at creating a defensible model using multiple regression involved using the individual DoN FTE hire types as the independent variables and expenditures as the dependent variable. All current hire types were initially used and the FTE with the highest p -value was removed. This process was repeated 6 times until the following equation was derived:

$$\begin{aligned} \text{Total DoN Civilian Labor Expenditures (FY17K\$)} = & - \\ & 19,674,410.69 + (9455.82 * AA \text{ FTEs}) + (957.6 * FNI \text{ FTEs}) + (538.31 * WG \text{ FTEs}). \end{aligned}$$

With an Adjusted R^2 of 0.84, which indicates that the derived equation accounts for 84 percent of the variation seen in the data and a Significant F 0.003, the model can be used to estimate DoN total expenditures if given projections for the AA, FNI, and WG hire types.¹⁰ These independent variables projections were achieved by using the linear regressions derived in Appendix A and the test for multicollinearity showed that the independent variables were fairly independent from each other with values less than 0.20. Appendix C outlines the process by which the preceding equation was derived as well as the resulting data that was used to populate Figure 19.

¹⁰ p -values for AA, FNI, and WG were 0.00, 0.10, and 0.10 respectively.



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 19. Changes in Total Expenditures, 2007–2028, Using Multiple Regression and Select Hire Types to Project Expenditures.

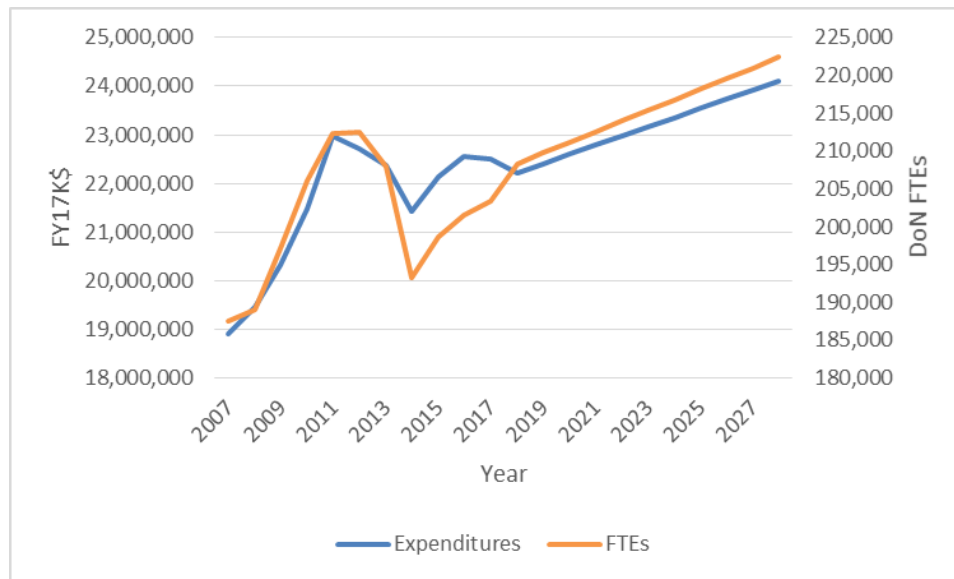
Figure 19 is comparable to the projections made in Figures 17 and 18, however, none of the regressions used to project the independent variables met the predetermined threshold of 0.75. Since the estimations of AA, FNI, and WG FTEs would not withstand scrutiny due to their poor correlation coefficients, a second effort was made to derive a valid projection of FTEs using the different hire types as independent variables. It was hypothesized that by using multiple regression techniques to derive the equation for total FTEs, the strongest independent variables would be used. The resulting projection for total DoN FTEs would then be placed into the linear regression model for total expenditures based on FTEs created in Figure 16.

A process similar to developing the preceding equation was undertaken and after 7 iterations, the following equation was the result:

$$\text{Total DoN FTEs} = 97,700.01 + (0.263 * \text{GS FTEs}) + (216.734 * \text{SES FTEs}).$$

Appendix D outlines the process to create the regression as well as the resulting estimations. With an Adjusted R^2 of only 0.58, which was lower than the previous

multiple regression model, and a slightly higher Significant F of 0.021; the model is not the best for projecting total FTEs. Additionally, there is the issue that the projections used to determine the independent variables of SES and GS FTEs have poor correlation coefficients that were 0.3 or less. Figure 20 is a visual representation of the information found in Appendix D.



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 20. Changes in Total Expenditures and FTEs, 2007–2028, Using Multiple Regression and Select Hire Types to Project Total FTEs.

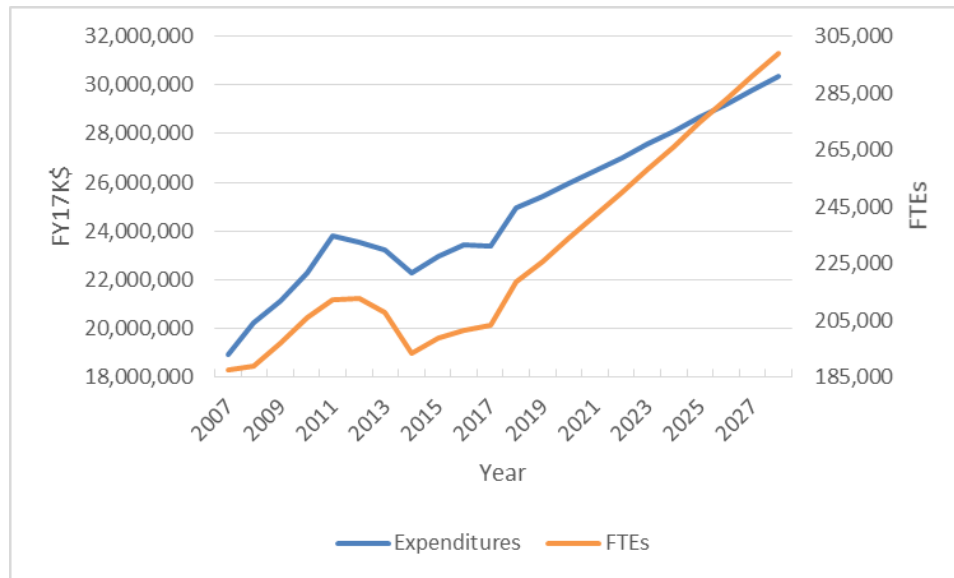
Attempts at creating multiple regression with the number of FTEs as independent variables failed to produce defensible results because information encompassed shifts in the entire DoN and was not detailed enough.

3. Multiple Regression Models for each BSO to Calculate DoN Labor Costs

A final attempt to create defensible projections for DoN FTEs and expenditures was undertaken by applying multiple regression techniques at a lower level, the

individual BSOs. The results were then combined to produce total DoN values for FTEs and expenditures.

Appendix E outlines the final attempt to model the changes of each BSO by creating a multiple regression model based on the different hire types in each BSO.¹¹ The result of combining these results can be seen in Figure 21 and Table 3.



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 21. Changes in DoN Total FTEs and Expenditures, 2007–2028, Adjusting for Trends in the Different Hire Types of Each BSO.

¹¹ Excel data was summarized due to the large volume.

Figure 22. Total FTEs and Expenditures, 2018–2028, Adjusting for Trends in the Different Hire Types of Each BSO.

	FTEs	Expenditures (FY17K\$)
2018	218,422	24,929,427
2019	225,561	25,436,580
2020	233,697	25,943,734
2021	241,838	26,450,887
2022	250,024	27,000,570
2023	258,210	27,559,196
2024	266,397	28,116,042
2025	274,584	28,672,888
2026	282,771	29,229,734
2027	290,957	29,786,581
2028	299,146	30,343,105

Adapted from C. Greaver, non-archived email, January 27, 2017.

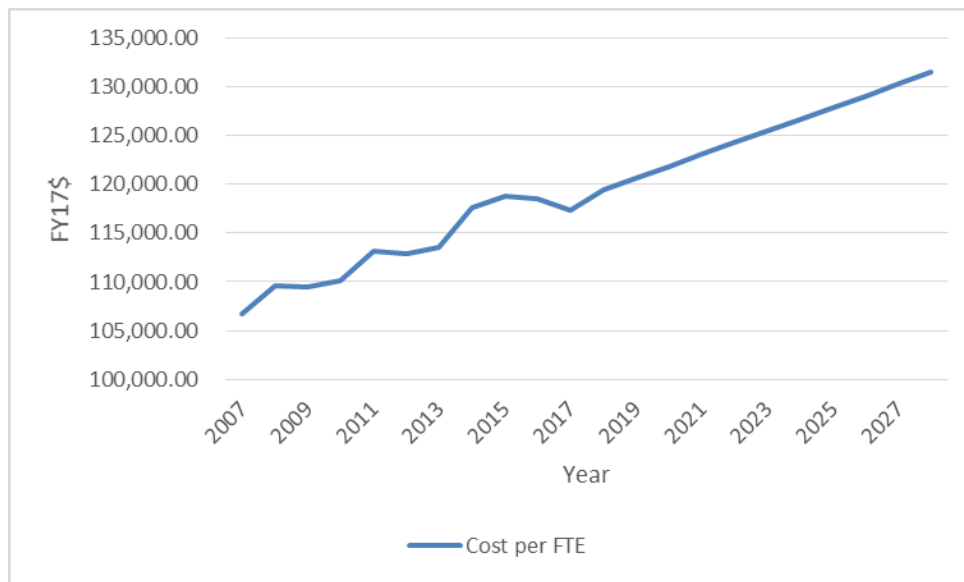
Even with the use of multiple regression models and checks for multicollinearity, of the 58 regression models for the independent variables, only 13 regression models (22 percent), were defensible.

Attempts to project future DoN expenditures and number of FTEs using regression equations failed to produce defensible results because the historical information was not detailed enough. It is possible to create regressions that meet the predetermined thresholds to calculate expenditures and total FTEs, however the regressions created to project the number of FTEs by hire type would not stand up to scrutiny.

B. MODELING CHANGES IN EXPENDITURES

It may not be possible to create defensible predictions on the growth of DoN FTEs and associated expenditures, but it is possible to predict the changes in civilian compensation. Figure 14 shows that the amount spent for the average FTE grew at a predictable rate. Figure 22 shows the projected growth in the cost per FTE in the period 2018–2028.

With an R^2 value of 0.91, the regression model closely mirrors the historical data and can be used as a reliable model to predict future changes in the Cost per FTE. This growth will be primarily driven by the rapid increase in benefits expense as seen in Figure 8. Assuming that the rate¹² of growth in benefits expense continues, the benefit expense per FTE will increase to \$33,988.74 by 2028 (Figure 23). Basic Compensation per FTE also grew at a steady rate meaning that it is possible to predict future growth¹³ (Figure 24).

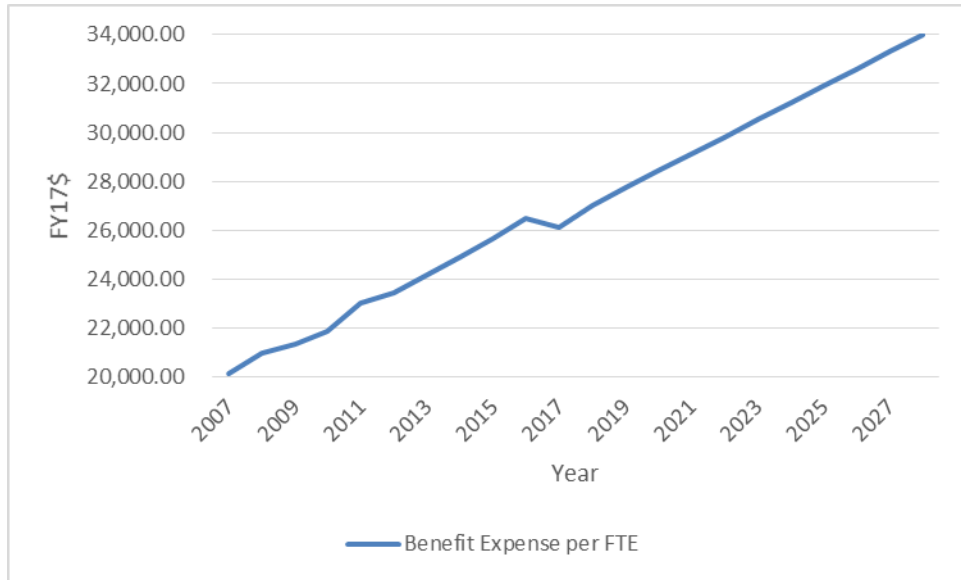


Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 23. Change in Cost per FTE 2007–2028.

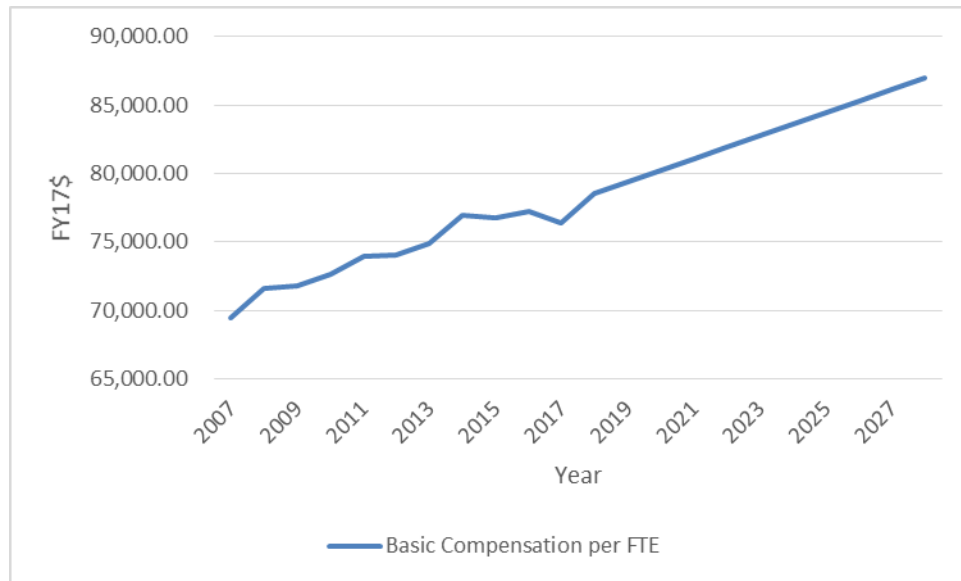
¹² The equation for the trendline is *Benefit Expense per FTE (FY17\$)* = 695.94x+19374 where x is the year (2007 = 1, 2008=2, etc.). The associated R^2 value is .995

¹³ The equation for the trendline is *Basic Compensation per FTE (FY17\$)* = 841.01x+69308 where x is the year (2007 = 1, 2008=2, etc.). The associated R^2 value is .96



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 24. Change in Benefit Expense per FTE 2007–2028.



Data from 2007 to 2017 was derived from the information in the OP08 database maintained by the Department of the Navy. Values from 2018 to 2028 are projections. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 25. Change in Basic Compensation per FTE 2007–2028.

C. SUMMARY

1. Modeling Labor Costs and FTEs

Figure 15 was an initial attempt to model the changes in the DoN civilian labor force and associated expenditures. The poor R^2 values meant that the derived models were unsuitable for creating projections but could highlight an important trend: that the expenditures on civilian labor would grow at a faster rate than the size of the civilian labor force. This trend was previously discussed in Figure 14 (Chapter V) where the cost per FTE grew 11.9 percent from 2007 to 2016.

Since time was proven to be an ineffective independent variable, the second attempt to model costs was made by placing the number of FTEs as the independent variable. Figure 16 provided a defensible model that could be used to predict costs based on the total number of FTEs.

With a defensible model for costs, the goal now became developing a method to estimate the number of FTEs. Figure 15 had shown that it was not possible to model civilian FTE numbers as whole so each individual hire type was modeled. After the individual hire types were modeled, the results were combined to create a DoN total. This effort also proved inadequate because only two of the five hire types had R^2 values that were suitable.

After creating and testing the initial models, it became evident that it would be necessary to further subdivide the information to create a useable model. A third attempt was undertaken by modeling the growth of FTEs in the individual BSOs to create a total DoN number. Besides possibly providing more accurate models by taking into account the trends of the individual BSOs, this method also assisted in the analysis of changes in the different subunits. This method resulted in 20 regressions to create a total number of FTEs, however, only nine met or surpassed the R^2 threshold of 0.75.

Since modeling the BSO would not be viable, another attempt was undertaken by modeling the different hire types in each BSO. This effort also proved fruitless as a smaller percent of the regressions met the R^2 threshold. Even though it was not possible

to adequately estimate the total number of FTEs using simple linear regression, it was postulated that it may be possible to create models using multiple regression techniques.

The first attempt with multiple regression involved creating a regression that estimated total expenditures using the different hire types as the independent variables (Appendix C). The derived equation was shown that it could be used to predict expenditures based on the using select hire type projections, however, the models used to derive the equations had poor correlation coefficients, which made them unsuitable.

A second attempt at multiple regression was made, this time by estimating the total number of FTEs by using the different hire type as independent variables. If a total number of FTEs could be determined, then the result could be inserted into the expenditures equation derived from Figure 16. This line of effort produced an equation that was not as strong as the previous multiple regression equation. Additionally, projecting the independent variables relied on using equations with correlation coefficients that did not meet the predetermined level of 0.75.

A final attempt at multiple regression was done at the BSO level. Appendix E shows the regression equations used, but estimation of the number of FTEs still proved elusive and as a result the effort did not produce defensible results.

The primary reason all efforts to project total expenditures and FTEs for the upcoming ten years failed is because there is no defensible way to estimate the number of FTEs based on the information provided. There was too much variation in the numbers of the FTEs to create a defensible regression model. More detailed information on the number of FTEs at levels below the BSO would be necessary to create the defensible models.

2. Modeling Changes in Civilian Labor Compensation

Even though it was not possible to adequately predict the change in DoN expenditures because of the variability of the number of FTEs, the composition of civilian compensation was very easy to model. The predictable growth of Cost per FTE allowed for an estimation of \$131,480 per average FTE in 2028. This growth will be

primarily driven by increases in basic compensation, which will remain the largest component of civilian labor costs. Benefit expense will continue to grow at a rapid rate becoming over a quarter of civilian compensation by 2028.

VII. CONCLUSIONS AND RECOMMENDATIONS

The period from 2007 to 2017, has seen tumultuous swings in defense appropriations. The Budget Control Act, the Affordable Care Act, Sequestration, and numerous continuing resolutions have affected the DoN budgets during this time period. In addition to these pressures on the DoN budget, labor market pressures have increased the cost of civilian labor in during same period. Given the current political landscape, these pressures will most likely remain in place for the near future while labor expenses will continue to rise increasing the costs of employing civilian FTEs. This analysis was undertaken in order to provide Navy leadership with as much information as possible on the civilian labor force and the trends seen from 2007 to 2016 in order to allow better-informed decisions when allocating scarce economic resources.

A. SUMMARY AND CONCLUSIONS

Historical data was collected from 2007 to 2017 for analysis. To allow for an accurate comparison, the dollar values were normalized to FY17 values. Chapter V sought to highlight the changes in the DoN civilian labor force and associated expenditures over this time period. This analysis proved problematic as the DoN had sizeable shifts in the total number of FTEs over this period, which made creating regressions with an acceptable correlation coefficient difficult. A more detailed analysis of the individual BSOs was also difficult as some, like BUMED, decreased dramatically while others saw sizeable shifts year to year in FTEs and expenditures that could not be easily explained. Other organizations, like NAVAIR, NAVSEA, USFF, and PACFLT grew at consistent and predictable rates.

In contrast to the number of FTEs and their associated expenditures, the composition of civilian compensation changed at predictable rates during this period. The average cost per DoN FTE grew 11.9 percent over this period, primarily driven by the rapid increase in benefit expense and a more gradual growth in basic compensation.

Chapter VI sought to take the previously identified trends and create models that could be used to project their effects into the near future. Calculating future

estimations of the size and expense of the DoN civilian labor force proved to be impossible given the information provided. Using linear regression as well as multiple regression, it was possible to create models that estimated future expense given the number of FTEs. However, predicting the number of FTEs in the DoN and even in the individual BSOs proved impossible due to the variations seen in the number of FTEs.

There was variation in the total number of FTEs and in the different hire types over the historical period being analyzed. Coupled with the requirement for p -values equal to or less than 0.10 as well as R^2 values equal to or above 0.75, very few regressions were defensible. More historic data points could have alleviated this issue but that would have minimized the effects that recent events had on the DoN civilian labor force that were of interest. A future analysis of these issues should find more detailed data from each of the BSOs, which can be used to create accurate projections of the number of FTEs.

Even though the projections created in Chapter VI should be treated with a level of skepticism. Because of the previously discussed reasons, they do indicate some noteworthy trends. First, the DoN can expect to spend approximately \$270-\$300 billion over the next ten years to pay for civilian labor. The second trend that the projections imply is that the cost of labor will continue to rise at a much faster rate than the number of civilians employed by the DoN. Third, NAVAIR, NAVSEA, USFF, and PACFLT will remain the largest BSOs, accounting for over 50 percent of civilians and expenditures in the DoN. Lastly, most of the growth in the BSOs will occur in the Operations and Maintenance as well as the NWCF appropriations.

In contrast to the efforts to calculate FTEs and expenditures, predicting changes in civilian compensation was relatively simple. Due to their predictable nature, it was easy to see that the average cost per DoN FTE would continue its annual one percent growth. Basic compensation would continue to grow at approximately one percent per year while benefits expense would grow, on average three percent per year.

B. RECOMMENDATIONS FOR FURTHER STUDY

This report was able to analyze historical data and highlight some noticeable trends that will have and will continue to affect the DoN civilian labor force and associated expenditures. However, more research can be done to further understand the civilian labor force and costs associated with employing civilians to manage expenditures in a time of fiscal constraint.

The first recommended area of study would be to understand the composition of the benefits expense. Considering that this one expense has grown, at a steady rate, 40 percent in the last ten years, it is important to understand why and what specific portion of the benefits expense is driving the growth. Increases in health care costs as well as the effects of changes in healthcare legislation on benefits expenditures should be investigated to understand their effects.

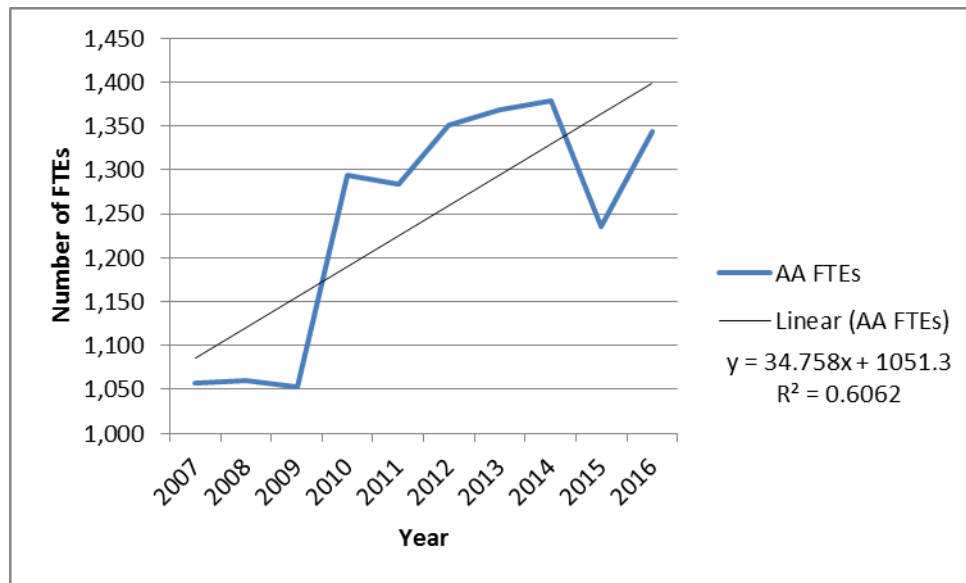
A second recommended area of study would be to conduct a cost-benefit analysis on the number and functions of the DP hire type in the different BSOs. Tremendous growth of the DP hire type has occurred mainly in the Operations and Maintenance as well as the NWCF appropriations and these FTEs tend to be more expensive than the average DoN FTE.

A third area of additional study would be on the return on investment of the additional hires in USFF and PACFLT to see if the additional FTEs have increased the effectiveness of those organizations, or if they could best be served by another, less expensive hire type or contract labor.

A final area for additional study would be an evaluation of the civilian labor force to identify opportunities for contract personnel to provide those services vice direct hires by the DoN.

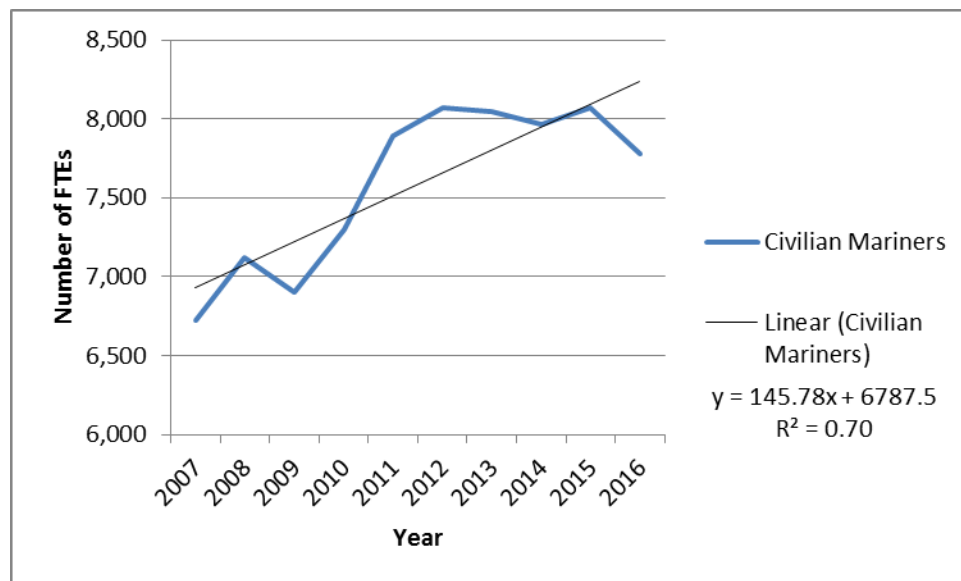
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APPENDIX A. DON-WIDE CHANGES IN HIRE TYPES, 2007–2016



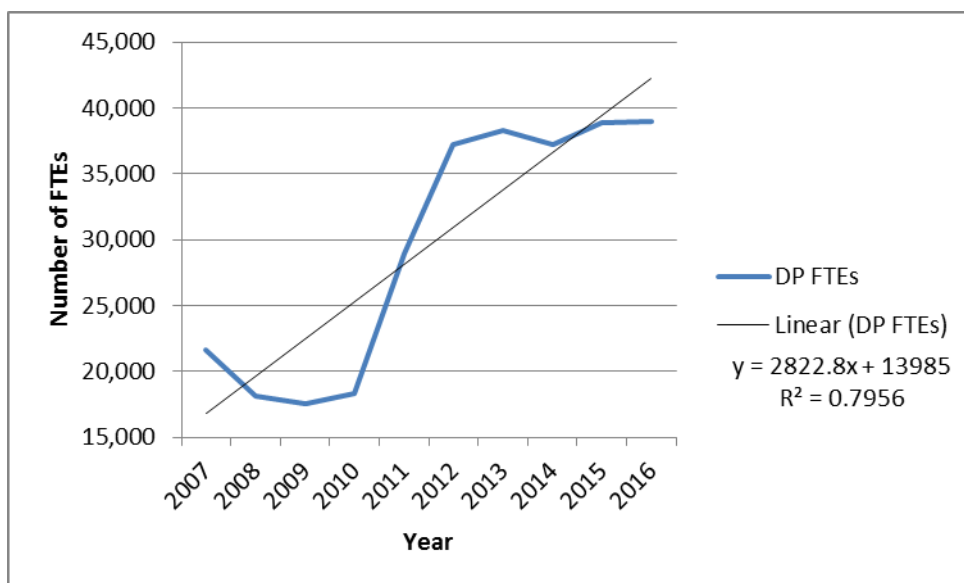
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 26. Changes in DoN AA FTEs 2007–2016



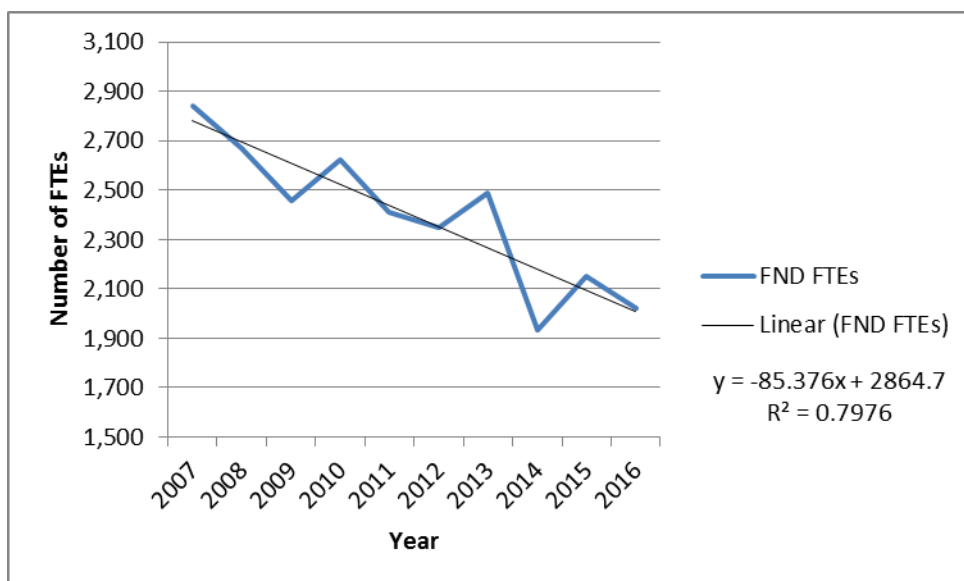
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 27. Changes in DoN Civilian Mariner FTEs 2007–2016.



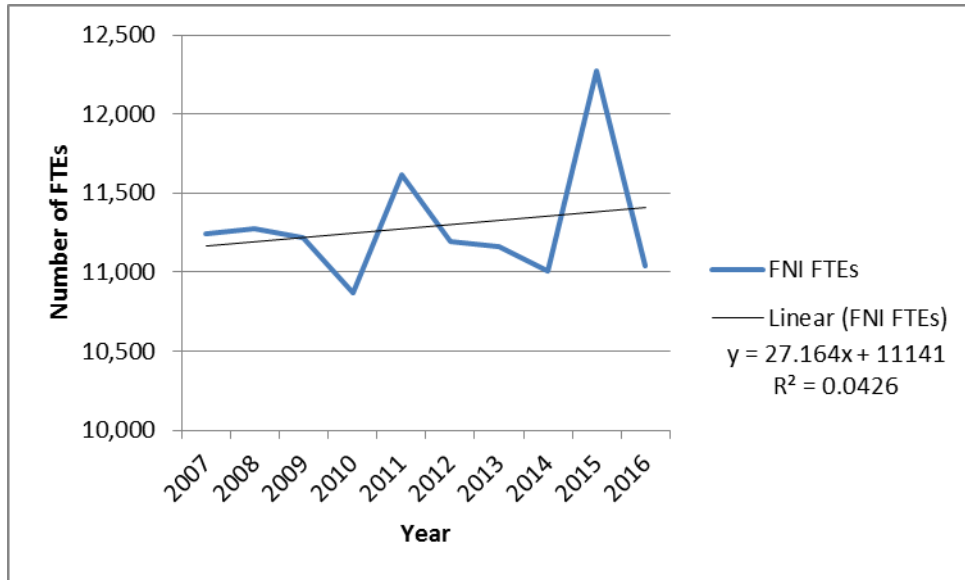
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 28. Changes in DoN DP FTEs 2007–2016.



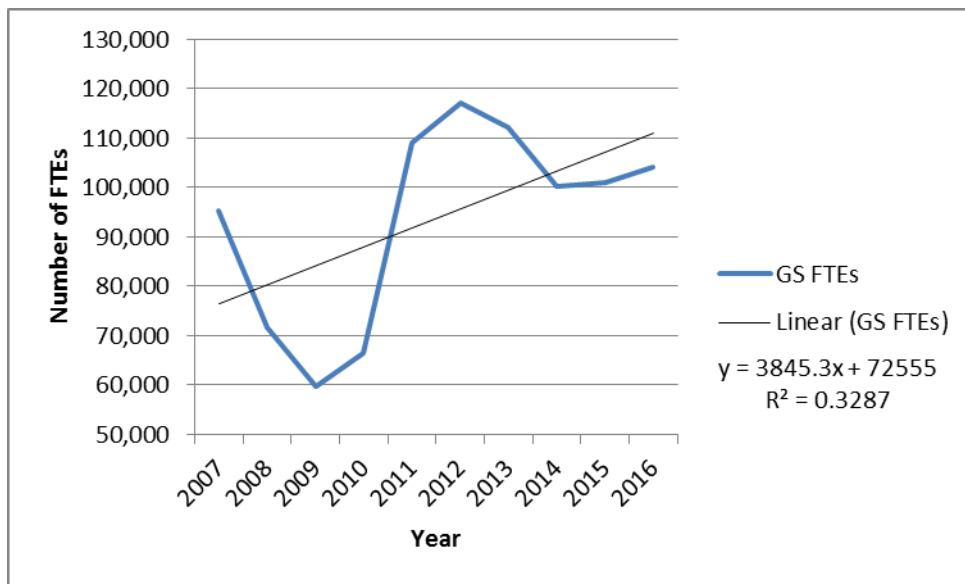
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 29. Changes in DoN FND FTEs 2007–2016.



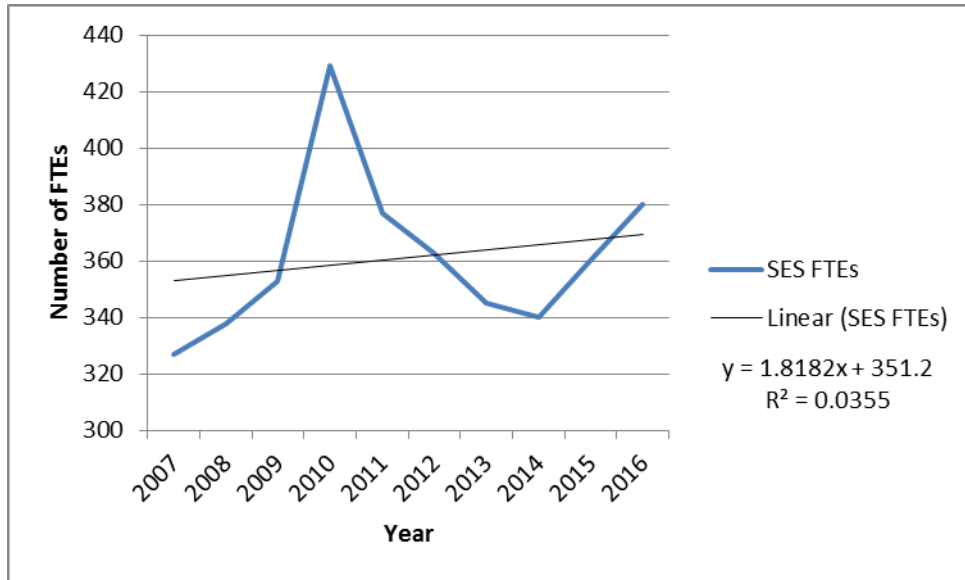
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 30. Changes in DoN FNI FTEs 2007–2016.



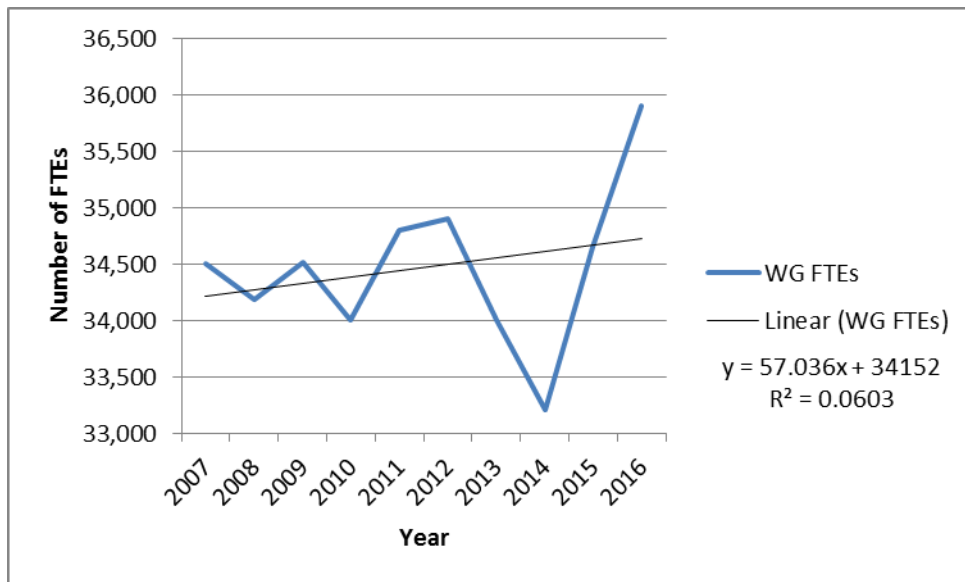
Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 31. Changes in DoN GS FTEs 2007–2016.



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 32. Changes in DoN SES FTEs 2007–2016.



Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 33. Changes in DoN WG FTEs 2007–2016..

APPENDIX B. FTE TRENDS OF INDIVIDUAL BUDGET SUBMITTING OFFICES

$$BSO\ 11\ FTEs = -178.44x + 3148.2\ R^2: 0.79$$

$$BSO\ 12\ FTEs = -13.388x + 4764.7\ R^2: 0.05$$

$$BSO\ 14\ FTEs = 17.285x + 2707.1\ R^2: 0.46$$

$$BSO\ 15\ FTEs = -51.412x + 1727.3\ R^2: 0.26$$

$$BSO\ 18\ FTEs = -1525.4x + 17434\ R^2: 0.61$$

$$BSO\ 19\ FTEs = 332.65x + 21930\ R^2: 0.85$$

$$BSO\ 22\ FTEs = 326.22x + 6272.4\ R^2: 0.72$$

$$BSO\ 23\ FTEs = -118.11x + 8137.4\ R^2: 0.55$$

$$BSO\ 24\ FTEs = 466.16x + 22232\ R^2: 0.87$$

$$BSO\ 25\ FTEs = 172.53x + 15988\ R^2: 0.16$$

$$BSO\ 27\ FTEs = 394.01x + 19668\ R^2: 0.49$$

$$BSO\ 30\ FTEs = 34.661x + 782.07\ R^2: 0.9$$

$$BSO\ 33\ FTEs = 151.76x + 7747.9\ R^2: 0.76$$

$$BSO\ 39\ FTEs = 262.61x + 6931.7\ R^2: 0.97$$

$$BSO\ 41\ FTEs = -63.6x + 826.8\ R^2: 0.80$$

$$BSO\ 52\ FTEs = -493x + 18894\ R^2: 0.69$$

$$BSO\ 60\ FTEs = 742.24x + 17054\ R^2: 0.95$$

$$BSO\ 70\ FTEs = 700.36x + 16798\ R^2: 0.94$$

$$BSO\ 72\ FTEs = 4.982x + 405\ R^2: 0.26$$

$$BSO\ 74\ FTEs = 21.242x + 220.87\ R^2: 0.01$$

where x is the year for which the FTE is to be calculated using sequential values (i.e., $x = 1$ for 2007, $x = 2$ for 2008, ..., $x = 12$ for 2018, etc.)

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APPENDIX C. MULTIPLE REGRESSION MODEL DATA FOR ESTIMATING TOTAL EXPENDITURES BASED ON A SELECT NUMBER OF HIRE TYPES

		FTEs							
Year	Total LBR	AA	CIV MAR	DP	FND	FNI	GS	SES	WG
2007	18917892	1057	6721	21676	2842	11247	95164	327	34504
2008	19451728	1060	7118	18182	2669	11277	71633	338	34182
2009	20331010	1053	6899	17578	2459	11218	59841	353	34509
2010	21487374	1294	7303	18366	2624	10872	66476	429	34006
2011	22985995	1283	7899	28932	2411	11615	109117	377	34796
2012	22722854	1351	8072	37176	2347	11196	117094	363	34896
2013	22373479	1368	8048	38246	2491	11159	112204	345	34008
2014	21434834	1379	7971	37177	1934	11005	100272	340	33212
2015	22135134	1236	8079	38839	2152	12275	101053	360	34648
2016	22552748	1344	7783	38930	2022	11038	104188	380	35896
SUMMARY OUTPUT		Run 1 for total expenditures							
Regression Statistics									
Multiple R	0.986689478								
R Square	0.973556125								
Adjusted R Square	0.762005128								
Standard Error	693265.6694								
Observations	10								
ANOVA									
	df	SS	MS	F	Significance F				
Regression	8	1.77E+13	2.21E+12	4.601993	0.346464				
Residual	1	4.81E+11	4.81E+11						
Total	9	1.82E+13							
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%	
Intercept	-98696146.4	89036475	-1.10849	0.467272	-1.2E+09	1.03E+09	-6.6E+08	4.63E+08	
AA	36639.35029	38235.03	0.958267	0.513565	-449183	522461.5	-204767	278045.8	
CIV MAR	-288.6645041	3478.15	-0.08299	0.947285	-44482.7	43905.42	-22248.8	21671.51	
DP	-244.5295948	223.4624	-1.09428	0.471361	-3083.89	2594.829	-1655.42	1166.356	
FND	692.8786687	2047.582	0.338389	0.792275	-25324.1	26709.87	-12235	13620.8	
FNI	3594.157988	4078.145	0.881322	0.540106	-48223.6	55411.91	-22154.2	29342.55	
GS	-57.48771893	79.11291	-0.72665	0.599954	-1062.71	947.7371	-556.987	442.0115	
SES	-57797.6215	74300.2	-0.77789	0.579121	-1001871	886276	-526911	411315.4	
WG	1974.223724	1641.278	1.202858	0.44154	-18880.2	22828.64	-8388.4	12336.85	
	AA	CIV MAR	DP	FND	FNI	GS	SES	WG	
AA	1								
CIV MAR	0.864968872	1							
DP	0.776856717	0.889835	1						
FND	-0.639007325	-0.70583	-0.75227	1					
FNI	-0.168980417	0.282106	0.249707	-0.13486	1				
GS	0.654537783	0.758247	0.854179	-0.40876	0.235615	1			
SES	0.378158628	0.145563	-0.10333	-0.06539	-0.17904	-0.20051	1		
WG	-0.013708597	0.057005	0.201065	-0.12135	0.196087	0.250234	0.218414	1	

Initial Excel Regression Data to Calculate Total DoN Expenditures for Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total LBR” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 34. First Attempt for Multiple Regression Equation that Projects Total Expenditures based on FTE Hire Types.

		FTEs						
Year	Total LBR	AA	DP	FND	FNI	GS	SES	WG
2007	18917892.44	1057	21676	2842	11247	95164	327	34504
2008	19451727.65	1060	18182	2669	11277	71633	338	34182
2009	20331010.19	1053	17578	2459	11218	59841	353	34509
2010	21487373.98	1294	18366	2624	10872	66476	429	34006
2011	22985994.82	1283	28932	2411	11615	109117	377	34796
2012	22722853.76	1351	37176	2347	11196	117094	363	34896
2013	22373479.17	1368	38246	2491	11159	112204	345	34008
2014	21434833.9	1379	37177	1934	11005	100272	340	33212
2015	22135133.92	1236	38839	2152	12275	101053	360	34648
2016	22552748.23	1344	38930	2022	11038	104188	380	35896
SUMMARY OUTPUT		Run 2 for total expenditures						
Regression Statistics								
Multiple F	0.986597173							
R Square	0.973373981							
Adjusted	0.880182915							
Standard	491898.2404							
Observati	10							
ANOVA								
	df	SS	MS	F	gnificance F			
Regressio	7	1.77E+13	2.53E+12	10.44493	0.090131			
Residual	2	4.84E+11	2.42E+11					
Total	9	1.82E+13						
Coefficients		Standard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	-92716256.64	37113336	-2.49819	0.129764	-2.5E+08	66969540	-2E+08	15654150
AA	33796.17373	12048.04	2.805117	0.107062	-18042.4	85634.72	-1383.94	68976.29
DP	-231.3990431	111.9734	-2.06655	0.17474	-713.182	250.3838	-558.36	95.5618
FND	626.040725	1335.746	0.468683	0.685417	-5121.21	6373.291	-3274.32	4526.399
FNI	3283.333887	1145.216	2.867	0.103173	-1644.13	8210.8	-60.6801	6627.348
GS	-52.63681182	37.82944	-1.39142	0.29866	-215.404	110.1301	-163.098	57.82462
SES	-52708.87673	29775.33	-1.77022	0.218709	-180822	75404.03	-139652	34234.66
WG	1868.357754	732.8061	2.549594	0.125519	-1284.65	5021.368	-271.426	4008.141
AA		DP	FND	FNI	GS	SES	WG	
AA	1							
DP	0.776856717	1						
FND	-0.639007325	-0.75227	1					
FNI	-0.168980417	0.249707	-0.13486	1				
GS	0.654537783	0.854179	-0.40876	0.235615	1			
SES	0.378158628	-0.10333	-0.06539	-0.17904	-0.20051	1		
WG	-0.013708597	0.201065	-0.12135	0.196087	0.250234	0.218414	1	

Excel Regression Data to Calculate Total DoN Expenditures for Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total LBR” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 35. Second Attempt for Multiple Regression Equation that Projects Total Expenditures based on FTE Hire Types..

		FTEs						
Year	Total LBR	AA	DP	FNI	GS	SES	WG	
2007	18917892.44	1057	21676	11247	95164	327	34504	
2008	19451727.65	1060	18182	11277	71633	338	34182	
2009	20331010.19	1053	17578	11218	59841	353	34509	
2010	21487373.98	1294	18366	10872	66476	429	34006	
2011	22985994.82	1283	28932	11615	109117	377	34796	
2012	22722853.76	1351	37176	11196	117094	363	34896	
2013	22373479.17	1368	38246	11159	112204	345	34008	
2014	21434833.9	1379	37177	11005	100272	340	33212	
2015	22135133.92	1236	38839	12275	101053	360	34648	
2016	22552748.23	1344	38930	11038	104188	380	35896	
SUMMARY OUTPUT		Run 3 for total expenditures						
Regression Statistics								
Multiple R	0.985114004							
R Square	0.970449601							
Adjusted R Square	0.911348804							
Standard Error	423114.777							
Observations	10							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	6	1.76E+13	2.94E+12	16.42025	0.021444			
Residual	3	5.37E+11	1.79E+11					
Total	9	1.82E+13						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	-83567046.65	27150856	-3.07788	0.054226	-1.7E+08	2839095	-1.5E+08	-2E+07
AA	31206.8093	9209.506	3.388543	0.042821	1898.051	60515.57	9533.495	52880.12
DP	-233.788535	96.216	-2.42983	0.093344	-539.991	72.41373	-460.22	-7.35731
FNI	3069.244676	903.3243	3.397722	0.042532	194.4636	5944.026	943.3943	5195.095
GS	-39.94820608	22.72737	-1.75771	0.177043	-112.277	32.38042	-93.434	13.53755
SES	-46609.43306	23035.88	-2.02334	0.136216	-119920	26701.01	-100821	7602.359
WG	1713.50917	562.6352	3.045507	0.055625	-77.0471	3504.065	389.4241	3037.594
	AA	DP	FNI	GS	SES	WG		
AA	1							
DP	0.776856717	1						
FNI	-0.168980417	0.249707	1					
GS	0.654537783	0.854179	0.235615	1				
SES	0.378158628	-0.10333	-0.17904	-0.20051	1			
WG	-0.013708597	0.201065	0.196087	0.250234	0.218414	1		

Excel Regression Data to Calculate Total DoN Expenditures for Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total LBR” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 36. Third Attempt for Multiple Regression Equation that Projects Total Expenditures based on FTE Hire Types.

		FTEs						
Year	Total LBR	AA	DP	FNI	SES	WG		
2007	18917892.44	1057	21676	11247	327	34504		
2008	19451727.65	1060	18182	11277	338	34182		
2009	20331010.19	1053	17578	11218	353	34509		
2010	21487373.98	1294	18366	10872	429	34006		
2011	22985994.82	1283	28932	11615	377	34796		
2012	22722853.76	1351	37176	11196	363	34896		
2013	22373479.17	1368	38246	11159	345	34008		
2014	21434833.9	1379	37177	11005	340	33212		
2015	22135133.92	1236	38839	12275	360	34648		
2016	22552748.23	1344	38930	11038	380	35896		
SUMMARY OUTPUT		Run 4 for total expenditures						
Regression Statistics								
Multiple F	0.969544762							
R Square	0.940017046							
Adjusted R	0.865038354							
Standard Error	522060.7923							
Observations	10							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	5	1.71E+13	3.42E+12	12.53712	0.014808			
Residual	4	1.09E+12	2.73E+11					
Total	9	1.82E+13						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	-47077398.32	21590743	-2.18044	0.094698	-1.1E+08	12868114	-9.3E+07	-1049243
AA	18473.37565	7016.145	2.632981	0.058005	-1006.57	37953.32	3516.029	33430.72
DP	-133.3430651	95.50926	-1.39613	0.235175	-398.519	131.8332	-336.954	70.26805
FNI	1949.6786	790.3361	2.466898	0.069177	-244.646	4144.003	264.8031	3634.554
SES	-14075.02621	16919.97	-0.83186	0.452266	-61052.4	32902.34	-50145.8	21995.75
WG	945.0019159	436.9249	2.162847	0.096581	-268.096	2158.1	13.54491	1876.459
	AA	DP	FNI	SES	WG			
AA	1							
DP	0.776856717	1						
FNI	-0.168980417	0.249707	1					
SES	0.378158628	-0.10333	-0.17904	1				
WG	-0.013708597	0.201065	0.196087	0.218414	1			

Excel Regression Data to Calculate Total DoN Expenditures for Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total LBR” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017

Figure 37. Fourth Attempt for Multiple Regression Equation that Projects Total Expenditures based on FTE Hire Types.

		FTEs							
Year	Total LBR	AA	DP	FNI	WG				
2007	18917892.44	1057	21676	11247	34504				
2008	19451727.65	1060	18182	11277	34182				
2009	20331010.19	1053	17578	11218	34509				
2010	21487373.98	1294	18366	10872	34006				
2011	22985994.82	1283	28932	11615	34796				
2012	22722853.76	1351	37176	11196	34896				
2013	22373479.17	1368	38246	11159	34008				
2014	21434833.9	1379	37177	11005	33212				
2015	22135133.92	1236	38839	12275	34648				
2016	22552748.23	1344	38930	11038	35896				
SUMMARY OUTPUT		Run 5 for total expenditures							
Regression Statistics									
Multiple R	0.964178488								
R Square	0.929640157								
Adjusted R Square	0.873352282								
Standard Error	505725.1806								
Observations	10								
ANOVA									
	df	SS	MS	F	Significance F				
Regression	4	1.69E+13	4.22E+12	16.51582	0.004365				
Residual	5	1.28E+12	2.56E+11						
Total	9	1.82E+13							
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%	
Intercept	-32352002.45	11974698	-2.7017	0.042697	-6.3E+07	-1570061	-5.6E+07	-8222406	
AA	13057.74618	2533.99	5.153038	0.003606	6543.918	19571.57	7951.634	18163.86	
DP	-60.46782353	36.8534	-1.64077	0.16177	-155.203	34.26686	-134.729	13.79356	
FNI	1486.960121	543.8776	2.733998	0.041084	88.87821	2885.042	391.0204	2582.9	
WG	654.6624044	254.6158	2.571178	0.049964	0.151734	1309.173	141.5993	1167.725	
	AA	DP	FNI	WG					
AA	1								
DP	0.776856717	1							
FNI	-0.168980417	0.249707	1						
WG	-0.013708597	0.201065	0.196087	1					

Excel Regression Data to Calculate Total DoN Expenditures for Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total LBR” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 38. Fifth Attempt for Multiple Regression Equation that Projects Total Expenditures based on FTE Hire Types.

		FTEs						
Year	Total LBR	AA	FNI	WG				
2007	18917892.44	1057	11247	34504	0			
2008	19451727.65	1060	11277	34182	0			
2009	20331010.19	1053	11218	34509	0			
2010	21487373.98	1294	10872	34006	0			
2011	22985994.82	1283	11615	34796	0			
2012	22722853.76	1351	11196	34896	0			
2013	22373479.17	1368	11159	34008	0			
2014	21434833.9	1379	11005	33212	0			
2015	22135133.92	1236	12275	34648	0			
2016	22552748.23	1344	11038	35896	0			
SUMMARY OUTPUT		Run 6 for total expenditures						
Regression Statistics								
Multiple F	0.944328759							
R Square	0.891756804							
Adjusted R	0.837635206							
Standard E	572613.8219							
Observati	10							
ANOVA								
	df	SS	MS	F	gnificance F			
Regressio	3	1.62E+13	5.4E+12	16.47691	0.002659			
Residual	6	1.97E+12	3.28E+11					
Total	9	1.82E+13						
Coefficients		Standard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	-19674410.69	10358356	-1.89938	0.106262	-4.5E+07	5671573	-4E+07	453742.2
AA	9455.822799	1433.062	6.598335	0.000582	5949.246	12962.4	6671.125	12240.52
FNI	957.6008024	495.762	1.931574	0.101622	-255.485	2170.687	-5.75419	1920.956
WG	538.3134854	276.8858	1.944172	0.099863	-139.202	1215.829	0.274498	1076.352
AA		FNI	WG					
AA	1							
FNI	-0.168980417	1						
WG	-0.013708597	0.196087	1					

Excel Regression Data to Calculate Total DoN Expenditures for Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total LBR” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 39. Multiple Regression Equation that Projects Total Expenditures based on FTE Hire Types.

Table 3. Historical Data and Expenditure Projection Based on Multiple Regression of Individual Hire Types.

Year	Total LBR	FTEs		
		AA	FNI	WG
2007	18917892	1057	11247	34504
2008	19451728	1060	11277	34182
2009	20331010	1053	11218	34509
2010	21487374	1294	10872	34006
2011	22985995	1283	11615	34796
2012	22722854	1351	11196	34896
2013	22373479	1368	11159	34008
2014	21434834	1379	11005	33212
2015	22135134	1236	12275	34648
2016	22552748	1344	11038	35896
2017	22505822	1344	11038	35896
2018	23558800	1434	11440	34779
2019	23944181	1468	11467	34836
2020	24329562	1503	11494	34893
2021	24714943	1538	11521	34951
2022	25100324	1573	11548	35008
2023	25485705	1607	11576	35065
2024	25871086	1642	11603	35122
2025	26256467	1677	11630	35179
2026	26641848	1712	11657	35236
2027	27027229	1746	11684	35293
2028	27412610	1781	11711	35350

Adapted from C. Greaver, non-archived email, January 27, 2017.

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APPENDIX D. MULTIPLE REGRESSION MODEL DATA FOR ESTIMATING TOTAL DEPARTMENT OF THE NAVY FULL TIME EQUIVALENTS BASED ON A SELECT NUMBER OF HIRE TYPES

		FTEs							
Year	Total FTEs	AA	CIV MAR	DP	FND	FNI	GS	SES	WG
2007	187461	1057	6721	21676	2842	11247	95164	327	34504
2008	188994	1060	7118	18182	2669	11277	71633	338	34182
2009	197213	1053	6899	17578	2459	11218	59841	353	34509
2010	206136	1294	7303	18366	2624	10872	66476	429	34006
2011	212267	1283	7899	28932	2411	11615	109117	377	34796
2012	212557	1351	8072	37176	2347	11196	117094	363	34896
2013	207869	1368	8048	38246	2491	11159	112204	345	34008
2014	193290	1379	7971	37177	1934	11005	100272	340	33212
2015	198642	1236	8079	38839	2152	12275	101053	360	34648
2016	201581	1344	7783	38930	2022	11038	104188	380	35896
SUMMARY OUTPUT		Run 1 for total FTEs							
Regression Statistics									
Multiple F	0.930889228								
R Square	0.866554754								
Adjusted	-0.20100721								
Standard E	9934.664721								
Observati	10								
ANOVA									
	df	SS	MS	F	Significance F				
Regression	8	6.41E+08	80114172	0.81171378	0.700728				
Residual	1	98697563	98697563						
Total	9	7.4E+08							
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%	
Intercept	-578674.247	1275914	-0.45354	0.7289328	-1.7E+07	15633353	-8634480	7477131	
AA	202.2697889	547.9173	0.369161	0.77486456	-6759.68	7164.219	-3257.14	3661.683	
CIV MAR	8.006919769	49.84273	0.160644	0.89859741	-625.305	641.3188	-306.688	322.7015	
DP	-1.79098074	3.20227	-0.55928	0.67535975	-42.4797	38.89771	-22.0093	18.42735	
FND	16.69868089	29.34234	0.569098	0.67062072	-356.131	389.5285	-168.562	201.9589	
FNI	16.23208347	58.44081	0.277753	0.82752478	-726.329	758.7929	-352.749	385.2128	
GS	-0.2945727	1.133707	-0.25983	0.83816481	-14.6997	14.11054	-7.45252	6.863372	
SES	-312.413567	1064.74	-0.29342	0.81830417	-13841.2	13216.39	-7034.92	6410.089	
WG	12.68589695	23.51991	0.539368	0.68509977	-286.163	311.5347	-135.813	161.1848	
	AA	CIV MAR	DP	FND	FNI	GS	SES	WG	
AA	1								
CIV MAR	0.864968872	1							
DP	0.776856717	0.889835	1						
FND	-0.63900732	-0.70583	-0.75227	1					
FNI	-0.16898042	0.282106	0.249707	-0.1348591	1				
GS	0.654537783	0.758247	0.854179	-0.4087605	0.235615	1			
SES	0.378158628	0.145563	-0.10333	-0.0653876	-0.17904	-0.20051	1		
WG	-0.0137086	0.057005	0.201065	-0.1213549	0.196087	0.250234	0.218414	1	

Initial Excel Regression Data to Calculate Total DoN Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total FTEs” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 40. First Attempt for Multiple Regression Equation that Projects Total DoN FTEs based on Hire Types.

		FTEs						
Year	Total FTEs	AA	DP	FND	FNI	GS	SES	WG
2007	187461	1057	21676	2842	11247	95164	327	34504
2008	188994	1060	18182	2669	11277	71633	338	34182
2009	197213	1053	17578	2459	11218	59841	353	34509
2010	206136	1294	18366	2624	10872	66476	429	34006
2011	212267	1283	28932	2411	11615	109117	377	34796
2012	212557	1351	37176	2347	11196	117094	363	34896
2013	207869	1368	38246	2491	11159	112204	345	34008
2014	193290	1379	37177	1934	11005	100272	340	33212
2015	198642	1236	38839	2152	12275	101053	360	34648
2016	201581	1344	38930	2022	11038	104188	380	35896
SUMMARY OUTPUT		Run 2 for total FTEs						
Regression Statistics								
Multiple R	0.929037681							
R Square	0.863111014							
Adjusted R	0.383999561							
Standard Error	7114.934692							
Observations	10							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	7	6.38E+08	91195192	1.80148274	0.402644			
Residual	2	1.01E+08	50622296					
Total	9	7.4E+08						
Coefficients		Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	-744543.264	536816.2	-1.38696	0.29980574	-3054277	1565191	-2312039	822952.4
AA	281.1332663	174.2658	1.613244	0.24803002	-468.672	1030.939	-227.72	789.9869
DP	-2.15519342	1.619611	-1.33069	0.31472777	-9.12382	4.81343	-6.88443	2.574047
FND	18.55261875	19.32055	0.960253	0.43825497	-64.577	101.6822	-37.8631	74.96834
FNI	24.85366182	16.56468	1.500401	0.2723016	-46.4184	96.12572	-23.515	73.22229
GS	-0.42912622	0.547174	-0.78426	0.51502601	-2.78343	1.925174	-2.02687	1.168615
SES	-453.564178	430.6776	-1.05314	0.40273268	-2306.62	1399.492	-1711.14	804.0081
WG	15.6223866	10.59948	1.473882	0.27843833	-29.9835	61.22829	-15.328	46.57273
AA		DP	FND	FNI	GS	SES	WG	
AA	1							
DP	0.776856717	1						
FND	-0.63900732	-0.75227	1					
FNI	-0.16898042	0.249707	-0.13486	1				
GS	0.654537783	0.854179	-0.40876	0.23561458	1			
SES	0.378158628	-0.10333	-0.06539	-0.1790422	-0.20051	1		
WG	-0.0137086	0.201065	-0.12135	0.1960872	0.250234	0.218414	1	

Excel Regression Data to Calculate Total DoN Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total FTEs” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 41. Second Attempt for Multiple Regression Equation that Projects Total DoN FTEs based on Hire Types.

		FTEs						
Year	Total FTEs	AA	DP	FNI	GS	SES	WG	
2007	187461	1057	21676	11247	95164	327	34504	
2008	188994	1060	18182	11277	71633	338	34182	
2009	197213	1053	17578	11218	59841	353	34509	
2010	206136	1294	18366	10872	66476	429	34006	
2011	212267	1283	28932	11615	109117	377	34796	
2012	212557	1351	37176	11196	117094	363	34896	
2013	207869	1368	38246	11159	112204	345	34008	
2014	193290	1379	37177	11005	100272	340	33212	
2015	198642	1236	38839	12275	101053	360	34648	
2016	201581	1344	38930	11038	104188	380	35896	
SUMMARY OUTPUT		Run 3 for total FTEs						
Regression Statistics								
Multiple R	0.894426797							
R Square	0.799999296							
Adjusted R Square	0.399997888							
Standard Error	7021.93487							
Observations	10							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	6	5.92E+08	98614705	1.9999912	0.304107			
Residual	3	1.48E+08	49307569					
Total	9	7.4E+08						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	-473407.86	450590.6	-1.05064	0.37058887	-1907388	960572.5	-1533811	586995.6
AA	204.3978572	152.8393	1.337339	0.27346673	-282.005	690.8006	-155.288	564.0842
DP	-2.22600564	1.596783	-1.39406	0.25761108	-7.30768	2.855671	-5.98382	1.531805
FNI	18.50916162	14.9914	1.234652	0.30484874	-29.2002	66.2185	-16.7711	53.78938
GS	-0.05310138	0.377179	-0.14079	0.89696096	-1.25345	1.147251	-0.94074	0.834538
SES	-272.808121	382.2992	-0.7136	0.52698094	-1489.45	943.8385	-1172.5	626.8808
WG	11.03347307	9.33739	1.181644	0.32248378	-18.6823	40.74921	-10.9408	33.00774
	AA	DP	FNI	GS	SES	WG		
AA	1							
DP	0.776856717	1						
FNI	-0.16898042	0.249707	1					
GS	0.654537783	0.854179	0.235615	1				
SES	0.378158628	-0.10333	-0.17904	-0.200512	1			
WG	-0.0137086	0.201065	0.196087	0.25023435	0.218414	1		

Excel Regression Data to Calculate Total DoN Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total FTEs” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 42. Third Attempt for Multiple Regression Equation that Projects Total DoN FTEs based on Hire Types.

		FTEs						
Year	Total FTEs	AA	DP	FNI	GS	SES		
2007	187461	1057	21676	11247	95164	327		
2008	188994	1060	18182	11277	71633	338		
2009	197213	1053	17578	11218	59841	353		
2010	206136	1294	18366	10872	66476	429		
2011	212267	1283	28932	11615	109117	377		
2012	212557	1351	37176	11196	117094	363		
2013	207869	1368	38246	11159	112204	345		
2014	193290	1379	37177	11005	100272	340		
2015	198642	1236	38839	12275	101053	360		
2016	201581	1344	38930	11038	104188	380		
SUMMARY OUTPUT		Run 4 for total FTEs						
Regression Statistics								
Multiple R	0.840781437							
R Square	0.706913425							
Adjusted R Square	0.340555206							
Standard Error	7361.556157							
Observations	10							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	5	5.23E+08	1.05E+08	1.9295689	0.27198			
Residual	4	2.17E+08	54192509					
Total	9	7.4E+08						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	42067.16359	118287	0.355636	0.74007517	-286350	370484.6	-210103	294237
AA	38.33293565	62.98182	0.608635	0.5756357	-136.533	213.1985	-95.9347	172.6005
DP	-0.59136821	0.836091	-0.7073	0.51840998	-2.91273	1.729993	-2.37379	1.19105
FNI	4.313337661	9.401167	0.458809	0.67019496	-21.7885	30.41516	-15.7285	24.35518
GS	0.293242398	0.248873	1.178282	0.30399389	-0.39774	0.984224	-0.23732	0.823801
SES	144.4630921	153.5545	0.940794	0.40007767	-281.872	570.7986	-182.891	471.8177
	AA	DP	FNI	GS	SES			
AA	1							
DP	0.776856717	1						
FNI	-0.16898042	0.249707	1					
GS	0.654537783	0.854179	0.235615	1				
SES	0.378158628	-0.10333	-0.17904	-0.200512	1			

Excel Regression Data to Calculate Total DoN Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total FTEs” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 43. Fourth Attempt for Multiple Regression Equation that Projects Total DoN FTEs based on Hire Types.

		FTEs							
Year	Total FTEs	AA	DP	GS	SES				
2007	187461	1057	21676	95164	327				
2008	188994	1060	18182	71633	338				
2009	197213	1053	17578	59841	353				
2010	206136	1294	18366	66476	429				
2011	212267	1283	28932	109117	377				
2012	212557	1351	37176	117094	363				
2013	207869	1368	38246	112204	345				
2014	193290	1379	37177	100272	340				
2015	198642	1236	38839	101053	360				
2016	201581	1344	38930	104188	380				
SUMMARY OUTPUT			Run 5 for total FTEs						
Regression Statistics									
Multiple R	0.831558382								
R Square	0.691489343								
Adjusted R Square	0.444680817								
Standard Error	6755.410513								
Observations	10								
ANOVA									
	df	SS	MS	F	Significance F				
Regression	4	5.11E+08	1.28E+08	2.80172389	0.144256				
Residual	5	2.28E+08	45635571						
Total	9	7.4E+08							
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%	
Intercept	93718.77395	33316.19	2.81301	0.03741531	8076.783	179360.8	26585.04	160852.5	
AA	17.29026995	39.61097	0.436502	0.68067792	-84.533	119.1135	-62.5277	97.10829	
DP	-0.34924469	0.595107	-0.58686	0.5827936	-1.87902	1.180526	-1.54841	0.849925	
GS	0.318226313	0.222847	1.428003	0.21265361	-0.25462	0.891073	-0.13082	0.767274	
SES	182.4092037	118.7253	1.536397	0.18504199	-122.784	487.6024	-56.8281	421.6465	
	AA	DP	GS	SES					
AA	1								
DP	0.776856717	1							
GS	0.654537783	0.854179	1						
SES	0.378158628	-0.10333	-0.20051	1					

Excel Regression Data to Calculate Total DoN Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total FTEs” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 44. Fifth Attempt for Multiple Regression Equation that Projects Total DoN FTEs based on Hire Types.

		FTEs						
Year	Total FTEs	DP	GS	SES				
2007	187461	21676	95164	327				
2008	188994	18182	71633	338				
2009	197213	17578	59841	353				
2010	206136	18366	66476	429				
2011	212267	28932	109117	377				
2012	212557	37176	117094	363				
2013	207869	38246	112204	345				
2014	193290	37177	100272	340				
2015	198642	38839	101053	360				
2016	201581	38930	104188	380				
SUMMARY OUTPUT		Run 6 for total FTEs						
Regression Statistics								
Multiple R	0.824459208							
R Square	0.679732985							
Adjusted R Square	0.519599477							
Standard Error	6283.218214							
Observations	10							
ANOVA								
	df	SS	MS	F	Significance F			
Regression	3	5.03E+08	1.68E+08	4.24478921	0.062587			
Residual	6	2.37E+08	39478831					
Total	9	7.4E+08						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	94551.9026	30936.55	3.056317	0.02233021	18852.89	170250.9	34436.61	154667.2
DP	-0.18236061	0.424174	-0.42992	0.68226592	-1.22028	0.855555	-1.00661	0.641886
GS	0.337423621	0.203194	1.6606	0.14786078	-0.15977	0.834621	-0.05742	0.732266
SES	220.9650745	73.78739	2.994619	0.02417556	40.41385	401.5163	77.58288	364.3473
	DP	GS	SES					
DP	1							
GS	0.854178523	1						
SES	-0.10332945	-0.20051	1					

Excel Regression Data to Calculate Total DoN Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total FTEs” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. The highlighted value is the largest *p*-value and the associated independent variable was removed on subsequent attempts. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 45. Sixth Attempt for Multiple Regression Equation that Projects Total DoN FTEs based on Hire Types.

		FTEs						
Year	Total FTEs	GS	SES					
2007	187461	95164	327					
2008	188994	71633	338					
2009	197213	59841	353					
2010	206136	66476	429					
2011	212267	109117	377					
2012	212557	117094	363					
2013	207869	112204	345					
2014	193290	100272	340					
2015	198642	101053	360					
2016	201581	104188	380					
SUMMARY OUTPUT				Run 7 for total FTEs				
Regression Statistics								
Multiple R				0.818454104				
R Square				0.66986712				
Adjusted R				0.575543439				
Standard Error				5906.048821				
Observations				10				
ANOVA								
	df	SS	MS	F	Significance F			
Regression	2	4.95E+08	2.48E+08	7.1017916	0.020673			
Residual	7	2.44E+08	34881413					
Total	9	7.4E+08						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 90.0%	Upper 90.0%
Intercept	97700.00882	28253.16	3.458021	0.01057585	30891.9	164508.1	44172.18	151227.8
GS	0.262705839	0.098957	2.654755	0.03271515	0.02871	0.496701	0.075225	0.450187
SES	216.7340827	68.73841	3.153027	0.01608397	54.19358	379.2746	86.50377	346.9644
	GS	SES						
GS	1							
SES	-0.20051203	1						

Excel Regression Data to Calculate Total DoN Civilian FTEs based on the number of each hire type in the DoN. The top graph is the inputs with “Total FTEs” being the dependent variable and the different hire types being the independent variables. ANOVA data follows the input table and the bottom table is used to determine the independence between the different variables. Adapted from C. Greaver, non-archived email, January 27, 2017.

Figure 46. Multiple Regression Equation that Projects Total DoN FTEs based on Hire Types.

Table 4. Historical Data and Expenditure Projection Based on Multiple Regression of Individual Hire Types.

Year	Total FTEs	FTEs		Total LBR
		GS	SES	
2007	187461	95164	327	18917892
2008	188994	71633	338	19451728
2009	197213	59841	353	20331010
2010	206136	66476	429	21487374
2011	212267	109117	377	22985995
2012	212557	117094	363	22722854
2013	207869	112204	345	22373479
2014	193290	100272	340	21434834
2015	198642	101053	360	22135134
2016	201581	104188	380	22552748
2017	203317	104188	380	22505822
2018	208324	114853	371	22213370
2019	209729	118699	373	22403548
2020	211133	122544	375	22593725
2021	212537	126389	377	22783902
2022	213941	130235	378	22974080
2023	215346	134080	380	23164257
2024	216750	137925	382	23354435
2025	218154	141770	384	23544612
2026	219558	145616	386	23734789
2027	220963	149461	388	23924967
2028	222367	153306	389	24115144

Adapted from C. Greaver, non-archived email, January 27, 2017.

APPENDIX E. LINEAR AND MULTIPLE REGRESSION EQUATIONS FOR BSOS

BSO 11: Director, Field Support Activity (FSA), Adj R^2 : 0.622, Significant F : 0.032

Civilian Labor Expenditures (FY17K\$) = -53688.26+(5314.55**SES FTEs*)+(94.75**GS FTEs*)+(796.31**WG FTEs*)

SES FTEs = -0.77(*number of years*)+30.73 R^2 : 0.047, p -value: 0.068

GS FTEs = 104.87(*number of years*)+627.93 R^2 : 0.183, p -value: 0.053

WG FTEs = -23.4(*number of years*)+211.8 R^2 : 0.568, p -value: 0.007

BSO 12: Assistant for Administration (DONAA), Adj R^2 : 0.844, Significant F : 0.002

Civilian Labor Expenditures (FY17K\$) = 549084.68+(3840.7**SES FTEs*)+(5.3**GS FTEs*)+(-17643.15**FN Indirect FTEs*)

SES FTEs = -0.5091(*number of years*)+74.4 R^2 : 0.071, p -value: 0.003

GS FTEs = 521.86(*number of years*)+67.47 R^2 : 0.534, p -value: 0.055

FN Indirect = -0.2061(*number of years*)+11.53 R^2 : 0.283, p -value: 0.005

BSO 14: Chief of Naval Research (ONR), Adj R^2 : 0.964, Significant F : 3.84E⁻⁶

Civilian Labor Expenditures (FY17K\$) = 159821.449 + (222.2094**SES FTEs*)+(67.5343**DP FTEs*)

SES FTEs = 0.212(*number of years*)+39.733 R^2 : 0.073, p -value: 0.002

DP FTEs = 78.182(*number of years*)+2044.2 R^2 : 0.787, p -value: 1.83E⁻⁶

BSO 15: Naval Intelligence Activity (NIA), Adj R^2 : 0.388, Significant F : 0.032

Civilian Labor Expenditures (FY17K\$) = 472238.293+(22528.639**SES FTEs*)

$$SES\ FTEs = 1.933(number\ of\ years)+10.067\ R^2: 0.517, p\text{-value}: 0.032$$

BSO 18: Bureau of Medicine and Surgery (BUMED), Adj R^2 : 0.991, Significant F : $2.724E^{-8}$

$$Civilian\ Labor\ Expenditures\ (FY17K\$) = 43284.12+(288641.922*SES\ FTEs)+(723.805*WG\ FTEs)$$

$$SES\ FTEs = -0.158(number\ of\ years)+2.067\ R^2: 0.27, p\text{-value}: 2.473E^{-5}$$

$$WG\ FTEs = -100.78(number\ of\ years)+1045.9\ R^2: 0.774, p\text{-value}: 3.544E^{-5}$$

BSO 19: Naval Air Systems Command (NAVAIR), Adj R^2 : 0.846, Significant F : 0.001

$$Civilian\ Labor\ Expenditures\ (FY17K\$) = -3230440.39+(-371.62*WG\ FTEs)+(76688.05*FNI\ FTEs)$$

$$WG\ FTEs = -115.92(number\ of\ years)+5887.7\ R^2: 0.707, p\text{-value}: 0.001$$

$$FNI\ FTEs = 0.279(number\ of\ years)+103.67\ R^2: 0.272, p\text{-value}: 0.004$$

BSO 22: Chief of Naval Personnel (BUPERS), Adj R^2 : 0.971, Significant F : $1.567E^{-5}$

$$Civilian\ Labor\ Expenditures\ (FY17K\$) = 620711.105+(-370.887*AA\ FTEs)+(2435.509*WG\ FTEs)+(2867.541*FND\ FTEs)$$

$$AA\ FTEs = 74(number\ of\ years)+631.6\ R^2: 0.646, p\text{-value}: 0.113$$

$$WG\ FTEs = 18.121(number\ of\ years)+84.733\ R^2: 0.469, p\text{-value}: 0.007$$

$$FNI\ FTEs = 2.849(number\ of\ years)-9.267\ R^2: 0.641, p\text{-value}: 0.01$$

BSO 23: Naval Supply Systems Command (NAVSUP), Adj R^2 : 0.864, Significant F : 0.0

$$Civilian\ Labor\ Expenditures\ (FY17K\$) = 483114.1+(14806.421*SES\ FTEs)+(106.137*WG\ FTEs)$$

$$SES\ FTEs = -0.097(number\ of\ years)+7.533\ R^2: 0.065, p\text{-value}: 0.004$$

$$WG\ FTEs = -35.552(\text{number of years}) + 903.33 \quad R^2: 0.598, p\text{-value: } 0.007$$

BSO 24: Naval Sea Systems Command (NAVSEA), Adj R^2 : 0.999, Significant F : $3.4E^{-17}$

$$\text{Civilian Labor Expenditures (FY17K\$)} = -849556.491 + (10362.316 * SES\ FTEs) + (40.789 * GS\ FTEs) + (179.295 * DP\ FTEs) + (52461.42 * AA\ FTEs)$$

$$SES\ FTEs = -0.667(\text{number of years}) + 62.067 \quad R^2: 0.2127, p\text{-value: } 0.007$$

$$GS\ FTEs = 516.22(\text{number of years}) + 6084.7 \quad R^2: 0.7615, p\text{-value: } 0.006$$

$$DP\ FTEs = 379.54(\text{number of years}) + 11973 \quad R^2: 0.8869, p\text{-value: } 8.37E^{-5}$$

$$AA\ FTEs = 0.2121(\text{number of years}) + 12.933 \quad R^2: 0.538, p\text{-value: } 0.014$$

BSO 25: Naval Facilities Engineering Command (NAVFAC), Adj R^2 : 0.802, Significant F : 0.005

$$\text{Civilian Labor Expenditures (FY17K\$)} = -1338971 + (41.926 * GS\ FTEs) + (204.929 * WG\ FTEs) + (875.457 * FNI\ FTEs)$$

$$GS\ FTEs = 445.02(\text{number of years}) + 6366.5 \quad R^2: 0.43, p\text{-value: } 0.013$$

$$WG\ FTEs = -13.176(\text{number of years}) + 4848.1 \quad R^2: 0.036, p\text{-value: } 0.139$$

$$FNI\ FTEs = 8.497(\text{number of years}) + 1861.3 \quad R^2: 0.061, p\text{-value: } 0.008$$

BSO 27: Commandant of the Marine Corps (CMC), Adj R^2 : 0.987, Significant F : $1.7E^{-5}$

$$\text{Civilian Labor Expenditures (FY17K\$)} = -131278 + (7.212 * GS\ FTEs) + (10850.5 * AA\ FTEs) + (297.35 * WG\ FTEs) + (80.147 * FNI\ FTEs)$$

$$GS\ FTEs = 777.81(\text{number of years}) + 6561.9 \quad R^2: 0.547, p\text{-value: } 0.199$$

$$AA\ FTEs = 7.1818(\text{number of years}) + 0.6 \quad R^2: 0.8, p\text{-value: } 1.3E^{-5}$$

$$WG\ FTEs = -100.59(\text{number of years}) + 4739.3 \quad R^2: 0.693, p\text{-value: } 0.001$$

$$FNI\ FTEs = 77.018(\text{number of years}) + 3140 \quad R^2: 0.252, p\text{-value: } 0.022$$

BSO 30: Strategic Systems Program (SSP), Adj R^2 : 0.951, Significant F : $7.5E^{-5}$

Civilian Labor Expenditures (FY17K\$) = $49907.7 + (6010.22 * SES \text{ FTEs}) + (22.701 * GS \text{ FTEs}) + (49.881 * DP \text{ FTEs})$

$SES \text{ FTEs} = 0.418(\text{number of years}) + 7.4 \quad R^2: 0.718, p\text{-value: } 0.006$

$GS \text{ FTEs} = 78.164(\text{number of years}) + 184.8 \quad R^2: 0.469, p\text{-value: } 0.008$

$DP \text{ FTEs} = 33.812(\text{number of years}) - 119.67 \quad R^2: 0.442, p\text{-value: } 0.003$

BSO 33: Military Sealift Command (MSC), Adj R^2 : 0.761, Significant F : 0.003

Civilian Labor Expenditures (FY17K\$) = $322379 + (55642.1 * SES \text{ FTEs}) + (147.237 * GS \text{ FTEs})$

$SES \text{ FTEs} = 0.152(\text{number of years}) + 4.667 \quad R^2: 0.421, p\text{-value: } 0.007$

$GS \text{ FTEs} = 44.709(\text{number of years}) + 634.4 \quad R^2: 0.514, p\text{-value: } 0.031$

BSO 39: Space and Naval Warfare Systems Command (SPAWAR), Adj R^2 : 0.65, Significant F : 0.025

Civilian Labor Expenditures (FY17K\$) = $-3082626 + (61941.5 * SES \text{ FTEs}) + (125381 * AA \text{ FTEs}) + (184407 * FNI \text{ FTEs})$

$SES \text{ FTEs} = 0.327(\text{number of years}) + 18.2 \quad R^2: 0.442, p\text{-value: } 0.016$

$AA \text{ FTEs} = .1515(\text{number of years}) - 0.133 \quad R^2: 0.234, p\text{-value: } 0.023$

$FNI \text{ FTEs} = -0.024(\text{number of years}) + 15.933 \quad R^2: 0.03, p\text{-value: } 0.099$

BSO 41: Naval Systems Management Activity (NSMA), Adj R^2 : -0.034, Significant F : .471

*Civilian Labor Expenditures (FY17K\$) = 77626.5+(30587.3*SES FTEs)+(-59.682*GS FTEs)*

SES FTEs = -0.006(number of years)+0.133 R^2 : 0.003, p -value: 0.291

GS FTEs = 17.63(number of years)+136.13 R^2 : 0.111, p -value: 0.3

BSO 52: Naval Installations Command (CNIC), Adj R^2 : 0.873, Significant F : 0.001

*Civilian Labor Expenditures (FY17K\$) = 276685+(35.475*GS FTEs)+(1727.06*WG FTEs)+(-231.538*FND FTEs)*

GS FTEs = 115.78(number of years)+10383 R^2 : 0.025, p -value: 0.001

WG FTEs = -21.897(number of years)+717.93 R^2 : 0.829, p -value: 0.001

FND FTEs = -57.17(number of years)+1284.1 R^2 : 0.622, p -value: 0.043

BSO 60: U.S. Fleet Forces (USFF), Adj R^2 : 0.995, Significant F : 0.004

*Civilian Labor Expenditures (FY17K\$) = -736271+(45.728*GS FTEs)+(-109.643*DP FTEs)+(61697.1*AA FTEs)+(285.143*WG FTEs)+(-69415.1*CIVMAR FTEs)+(5174.68*FND FTEs)+(-3003.86*FNI FTEs)*

GS FTEs = 943.44(number of years)+5921.4 R^2 : 0.759, p -value: 0.077

DP FTEs = -10812(number of years)+219.07 R^2 : 0.034, p -value: 0.172

AA FTEs = 0.03(number of years)-0.067 R^2 : 0.084, p -value: 0.129

WG FTEs = 213.99(number of years)+7028.5 R^2 : 0.903, p -value: 0.01

CIVMAR FTEs = 0.588(number of years)-0.933 R^2 : 0.79, p -value: 0.073

FND FTEs = 6.2(number of years)+117.6 R^2 : 0.43, p -value: 0.049

FNI FTEs = 4.473(number of years)+171.2 R^2 : 0.287, p -value: 0.131

BSO 70: Pacific Fleet (PACFLT), Adj R^2 : 0.994, Significant F : $2E^{-6}$

Civilian Labor Expenditures (FY17K\$) = $561864 + (53.05 * GS\ FTEs) + (8668.69 * DP\ FTEs) + (138.98 * WG\ FTEs) + (-41175.8 * FND\ FTEs)$

$GS\ FTEs = 627.53(\text{number of years}) + 4674.7$ R^2 : 0.804, p -value: 0.0

$DP\ FTEs = -0.485(\text{number of years}) + 7.067$ R^2 : 0.027, p -value: 0.0

$WG\ FTEs = 262.87(\text{number of years}) + 7903$ R^2 : 0.802, p -value: 0.0

$FND\ FTEs = -0.321(\text{number of years}) + 9.267$ R^2 : 0.681, p -value: 0.003

BSO 72: Navy Reserve Force (RESFOR), Adj R^2 : 0.435, Significant F : 0.023

Civilian Labor Expenditures (FY17K\$) = $42308.6 + (-162.994 * WG\ FTEs)$

$WG\ FTEs = -2.624(\text{number of years}) + 53.133$ R^2 : 0.913, p -value: 0.023

BSO 74: Special Warfare Command (SPECWAR), Adj R^2 : 0.999, Significant F : $3.4E^{-17}$

Civilian Labor Expenditures (FY17K\$) = $10.9508 + (114.438 * GS\ FTEs)$

$GS\ FTEs = 21.242(\text{number of years}) + 220.87$ R^2 : 0.014, p -value: $3.4E^{-17}$

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